

QUALITY ASSURANCE PROJECT PLAN

FOR THE

MIDNITE MINE PHASE 1A RI/FS
STEVENS COUNTY, WASHINGTON

Contract Number: 68-W-98-228

Document Control Number: 1800.5.71.003

Revision 1

Including Addendum (Revision 1.1, November 12, 1999)

August 18, 1999

URS Greiner

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PREPARED BY:

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Seattle, Washington 98121

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APPROVALS			
NAME	TITLE	SIGNATURE	DATE
Elly Hale	EPA Work Assignment Manager		
Bruce Woods	EPA QA Manager		
Scott Myers	URSG Project Manager		
Alan Roberts	URSG Project Quality Assurance Manager		

QUALITY ASSURANCE PROJECT PLAN ADDENDUM

for the

MIDNITE MINE PHASE 1A RI/FS
STEVENS COUNTY, WASHINGTON

Revision 1.1
Date November 12, 1999

APPROVALS			
NAME	TITLE	SIGNATURE	DATE
Elly Hale	EPA Work Assignment Manager		
Bruce Woods	EPA QA Manager		
John Thackston	URSG Project Manager		
Alan Roberts	URSG Project Quality Assurance Manager		

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List of Acronyms

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
°C	degrees Celsius
ADQ	Audit of Data Quality
AESE	Associated Environmental Scientists and Engineers
AOIs	Areas of Interest
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society of Testing and Materials
bgs	below ground surface
BIA	U.S. Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BOM	U.S. Bureau of Mines
BTEX	benzene, toluene, ethylbenzene, xylenes
cc	cubic centimeter
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
cm/s	centimeters per second
COC	chain of custody
CPR	cardiopulmonary resuscitation
CSM	conceptual site model
DER	duplicate error ratio
DFC	decision flow chart
DMC	Dawn Mining Company
DOI	U.S. Department of Interior
DOT	Department of Transportation
DQA	Data Quality Assessment
DQO	Data Quality Objectives
E&E	Ecology and Environment, Incorporated
EPA	Environmental Protection Agency
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESI	Expanded Site Investigation
°F	degrees Fahrenheit
FD	field duplicate
ft	feet
FWS	U.S. Fish and Wildlife Service
G	glass

List of Acronyms

GC	gas chromatograph
GW	groundwater sample
HCl	hydrochloric acid
HNO ₃	nitric acid
HSM	Project Health and Safety Manager
HSP	Health and Safety Plan
HTRW	Hazardous, Toxic, Radioactive Waste
ICP	inductively coupled plasma
ICS	interference check sample
ID	identification
I.D.	inner diameter
IDW	investigation derived waste
IS	internal standard
LCS	laboratory control sample
LIMS	Laboratory Information Management System
MA	Mined Area
MCLs	Maximum Contaminant Levels
m	meters
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
ml	milliliter
MS	matrix spike
MSD	matrix spike duplicate
MSHA	Mine Safety and Health Administration
MSR	Management Systems Review
MTBE	methyl tertiary butyl ether
MW	monitoring well
NA	not applicable
NAREL	U.S. EPA National Air and Radiation Environmental Laboratory
NEPA	National Environmental Policy Act
NIST	National Institute for Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OD	outer diameter
OSHA	Occupational Safety and Health Administration
oz	ounce
P%	specified proportion

List of Acronyms

PARCC	precision, accuracy, representativeness, completeness, and comparability
pCi/L	picocuries per liter
PCOCs	potential chemicals of concern
PCP	pollution control pond
PE	performance evaluation
PIA	Potentially Impacted Area
PID	photoionization detector
PPE	personal protective equipment
PRG	preliminary remediation goal
PRT	post run tubing
PVC	polyvinyl chloride
QA	quality assurance
QA/QC	quality assurance/quality control
QAP	quality assurance plan
QAPP	quality assurance project plan
QC	quality control
RB	rinsate blank
RI/FS	remedial investigation/feasibility study
RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
RSD	relative standard deviation
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SHSM	Site Health and Safety Manager
SMI	Shepherd Miller Incorporated
SOPs	standard operating procedures
SOW	scope of work
START	Superfund Technical Assessment and Response Team
STI	Spokane Tribe of Indians
SVOCs	semivolatile organic compounds
TAL	target analyte list
TEPH	total extractable petroleum hydrocarbons
TPH	total petroleum hydrocarbons
TSA	technical systems audit
TVPH	total volatile petroleum hydrocarbons
UCL	upper confidence limit

List of Acronyms

UCUTFC	Upper Columbia Tribes Fishery Center
URSG	URS Greiner
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
VOCs	volatile organic compounds
WP	water pollution
WS	water supply
WSDH	Washington State Department of Health

SECTION A

Project Management

A.3 DISTRIBUTION LIST

QAPP Distribution	
Name	Organization
Elly Hale	U.S. Environmental Protection Agency
Bruce Woods	U.S. Environmental Protection Agency
Lorraine Edmond	U.S. Environmental Protection Agency
Rick Poeton	U.S. Environmental Protection Agency
Steve Richardson	ATSDR
John Griggs	NAREL
Corn Abeyta	Spokane Tribe of Indians
Donna Bruce	Bureau of Indian Affairs
Julie Campbell	U.S. Fish and Wildlife Service
Kelly Courtright	Bureau of Land Management
Eric Hoffman	Bureau of Land Management
Fred Kirschner	Spokane Tribe of Indians
Jim Le Bret	Bureau of Indian Affairs
Mary Verner Moore	Spokane Tribe of Indians
David Wynecoop	Spokane Tribe of Indians
John Riley	Pyrite Hydrochem
Barbara Williams	Idaho Water Resources Research Institute
Dave Delcour	Dawn Mining Company
Tom Shepherd	Shepherd Miller Inc.
Dr. Barbara Harper	Yakima Nation
Loren Setlow	U.S. EPA Office of Radiation and Indoor Air
John Griggs	National Air and Radiation Environmental Laboratory
Scott Myers	URS Greiner Woodward Clyde

Data Distribution					
Name	Title	Validated Data		Preliminary Data	
		Hard Copy	Electronic	Verbal	Fax
Elly Hale	EPA Work Assignment Manager	X	X		
Scott Myers	URSG Project Manager	X	X		
Fred Kirschner	Spokane Tribe of Indians	X	X		

SECTION A

Project Management

A.4 PROJECT ORGANIZATION

The Midnite Mine Phase 1A Remedial Investigation/Feasibility Study (RI/FS) will be performed under the auspices of the Environmental Protection Agency (EPA) Region 10 by its prime subcontractor, URS Greiner (URSG).

A project directory is shown in Table A.4-1. The project organization chart is shown on Figure A.4-1. Following are the key personnel for this project:

- EPA Work Assignment Manager – Elly Hale
- EPA Quality Assurance Manager – Bruce Woods
- URSG Project Manager – Scott Myers
- URSG Technical Advisor – John Thackston
- URSG Project Quality Assurance Manager – Alan Roberts
- URSG Project Chemist – Larry Brook
- URSG Project Health and Safety Manager (HSM) – Tim Joseph
- URSG Site Manager – Dave Nicholson
- URSG Site Health and Safety Manager (SHSM) – Kris Hinds
- URSG Site Sample Manager – Patricia Manrique
- Primary Analytical Laboratory - To Be Determined.

This organizational structure is designed to provide project control and proper quality assurance/quality control (QA/QC) for the field investigation. The roles and responsibilities of the key personnel are described below.

A.4.1 EPA Work Assignment Manager

Ms. Elly Hale is the EPA Work Assignment Manager and will be responsible for management and direction of the project.

A.4.2 EPA Quality Assurance Manager

Mr. Bruce Woods is the EPA Quality Assurance (QA) Manager. He will work directly with the EPA Work Assignment Manager and communicate directly with the URSG Project QA Manager. Mr. Woods will remain independent of direct job involvement and day-to-day operations and will be available to resolve any QA issues that arise. Specific function and duties of the EPA QA Manager include appraising contents of this Quality Assurance Project Plan (QAPP) and subsequent revisions; reviewing QA reports prepared by URSG, including QA evaluations and discussions presented in the RI/FS reports; and providing QA technical assistance to the EPA Work Assignment Manager. If EPA laboratories or Contract Laboratory

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Project Management

Program (CLP) laboratories are used, the EPA QA Manager has the responsibility to assess the effectiveness of the QA/QC program and to recommend modifications to the program when applicable. He is also responsible for reviewing and verifying the disposition of nonconformance and corrective action reports, and for periodic quality assurance audits of the laboratories. The EPA Quality Assurance Manager has the authority to halt work in case of major problems or nonconformances with the QA plan or if numerous minor problems are not corrected in a timely manner.

A.4.3 URSG Project Manager

The URSG Project Manager, Scott Myers, has primary responsibility for the completion of project activities. He will be responsible to the EPA for day-to-day control of planning, scheduling, and cost control. Mr. Myers will be directly responsible for the development of technical reports and other project documents and for implementing the Health and Safety Plan (HSP). The URSG Project Manager will assist project personnel in planning, coordinating, and controlling technical aspects of the project. He will be responsible for monitoring the quality of the technical and managerial aspects of the project, implementing the QAPP, implementing corrective measures, and maintaining communication with the EPA so that the objectives of the project are met.

A.4.4 URSG Technical Advisor

The URSG Technical Advisor, John Thackston, will provide strategic direction during the project regarding client and contract requirements, work quality, and compliance with budget and schedule requirements. The Technical Advisor will also review deliverables.

A.4.5 URSG Project Quality Assurance Manager

The Project Quality Assurance (QA) Manager works directly with the URSG Project Manager and other project personnel. Mr. Alan Roberts of URSG, who will serve as the URSG Project QA Manager, has the responsibility to monitor and verify that the work is performed in accordance with the QAPP, the Standard Operating Procedures (SOPs), and other applicable procedures. The URSG Project QA Manager also has the responsibility to assess the effectiveness of the QA/QC program and to recommend modifications to the program when applicable. The URSG Project QA Manager is responsible for assuring that personnel assigned to the project are trained and indoctrinated relative to the requirements of the QA/QC Program. He is also responsible for reviewing and verifying the disposition of nonconformance and corrective action reports, and for periodic quality assurance audits. The URSG Project QA Manager will advise the URSG Project Manager on implementation of the QA/QC program, but the QA/QC functions of the URSG Project QA Manager and QA/QC coordinators are independent of the URSG Project Manager. The URSG Project QA Manager has the authority to halt work in case of major problems or nonconformances with the QA plan or if minor problems are not corrected in a timely manner.

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Project Management

A.4.6 URSG Project Chemist

The URSG Project Chemist, Larry Brook, will report to the URSG Project Manager and work directly with other project personnel. He will oversee analytical chemistry and data management activities. He will communicate directly with the URSG Site Manager to coordinate field sampling activities and will be responsible for QC of the analytical chemistry and data management documentation. He will resolve problems that may occur with laboratories, field activities, and sampling activities in accordance with the SAP.

A.4.7 URSG Project Health and Safety Manager

The URSG Project Health and Safety Manager (HSM), Tim Joseph, will work directly with the URSG Project Manager and other project personnel. The HSM has the responsibility to monitor and verify that the work is performed in accordance with the HSP. The URSG HSM will advise the URSG Project Manager regarding health and safety issues, but will function independently of the URSG Project Manager. The URSG HSM will also designate and oversee the activities of the Site Health and Safety Manager (SHSM).

A.4.8 URSG Site Manager

The URSG Site Manager, Dave Nicholson, will supervise site activities and will be responsible for the implementation of the QAPP in the field. The URSG Site Manager will report to the URSG Project Manager. The URSG Site Manager will be in charge of scheduling field activities and overseeing day-to-day field activities including all field measurements and data collection activities to check that they are conducted in accordance with the project QAPP.

A.4.9 URSG Site Health and Safety Manager

The URSG Site Health and Safety Manager (SHSM), Kris Hinds, is responsible for implementing the Site HSP. The SHSM coordinates preparation of the HSP; reviews proposed changes to the written HSP; provides guidance to field personnel; and, during incident investigations, conducts health and safety program audits, assists with implementing health and safety recommendations, validates requisitions for health and safety monitoring equipment and personal protective equipment (PPE); is responsible for seeking resolution of all health and safety-related corrective actions with the URSG Project Manager; and performs other duties related to health and safety at the site. The URSG Project Manager will initiate all health and safety corrective actions with the SHSM.

A.4.10 URSG Site Sample Manager

The URSG Site Sample Manager, Patricia Manrique, will report to the URSG Site Manager and be in communication with the field staff and Project Chemist. The URSG Site Sample Manager will inspect samples to confirm adequate sample volume has been collected for analyses requested, complete preservation, if required, and perform a radiation screen of the samples. The

SECTION A

Project Management

URSG Site Sample Manager will be responsible for documentation, packaging, and shipment of samples to the analytical laboratory. Documentation to be completed will include:

- Chain-of-Custody (COC) form
- Sample label
- Custody seal
- Courier/transportation forms
- Records retention at the site

A.4.11 Project Staff

Each member of the project staff will be responsible to the URSG Project Manager for completion of assigned project activities. Members of the project staff are responsible for understanding and implementing their project tasks along with associated QA/QC procedures.

A.4.12 Field and Laboratory Subcontractors

URSG may delegate to others, in writing, the responsibility of establishing and executing certain portions of the project, but shall retain responsibility for their conformance with contractual scopes of work. When organizations other than URSG are involved in the execution of activities covered by the requirements of the QAPP or project-specific SAP, the activities will be monitored by the URSG Project Manager, URSG Site Manager, URSG Project Chemist and URSG project staff as appropriate. Subcontractor activities shall be monitored against technical requirements specified in the Scope of Work, which is generated during the procurement process. When nonconformances are identified, the URSG Site Manager and project staff shall report the nonconformance to the URSG Project Manager and URSG QA Manager to determine if the project objectives have been affected. Resolution of nonconformances will be made and, if necessary, corrective actions implemented. In the case of subcontracted laboratories, performance will be measured through the data review and validation process. The laboratory QA Manager will be responsible for assuring data generated are of the quality specified in the scope of work and for documenting any nonconformances and associated corrective actions required during the analysis of project samples.

A.5 PROBLEM DEFINITION/BACKGROUND

A.5.1 Introduction

The Midnite Mine is an inactive hard rock uranium mine on the Spokane Indian Reservation in Stevens County, Washington. It is located approximately 40 miles northwest of Spokane and 8 miles northwest of Wellpinit, as shown on Figure A5.1-1. The Midnite Mine lies on the southwestern slope of Spokane Mountain at the southern end of the Huckleberry Mountains, a minor range in the north-south trending Selkirk system. The permitted area of the mine

SECTION A

Project Management

encompasses approximately 811 acres, of which 321 acres (an area approximately 0.5 miles wide by 1 mile long) were developed during mining operations. For the purposes of this Phase 1A RI/FS, the area disturbed during mining is known as the Mined Area (MA). The surrounding land potentially affected by mining activities is known as the Potentially Impacted Area (PIA).

Uranium was discovered at the mine in 1954. The Midnite Mine was leased by Dawn Mining Company (DMC) in 1954. During the period the mine was active, several pits or subpits were excavated. Several of these were subsequently backfilled with overburden and waste rock material as mining progressed. The mine ceased operations in 1981, leaving approximately two and one-half million tons of ore/proctore, and 33 million tons of waste rock onsite. Oxidation of sulfide-containing minerals, primarily pyrite, produces acidic water. Uranium and other radioactive constituents are chemically leached, dissolved, and transported in surface water, sediment, and groundwater.

The Midnite Mine is located within a single drainage basin drained by three intermittent streams, informally known as the Eastern, Central, and Western Drainages (Figure A.5.1-2). Water from these drainages ultimately discharges to Blue Creek via its confluence with the Eastern Drainage. The Eastern Drainage is east of the MA. Prior to mining, the north-south trending Central Drainage and Western Drainage extended from within the MA southward to their confluences with the Eastern Drainage. The portions of Western and Central Drainages within the MA were subsequently filled and covered with mine materials as mining proceeded. Presently, the surface expressions of Central and Western Drainages exist only in the PIA south of the MA.

In 1979 the Pollution Control Pond (PCP) was constructed at the toe of the South Spoils waste rock pile within the Central Drainage to contain surface water runoff and water seeping from mine waste dumps. Water from the PCP is periodically pumped into Pit 3 for temporary storage (SMI, 1996). Other seepage collection systems exist at the site, including the Western Drainage Pumpback System, Central Drainage Pumpback System, East Seep Pumpback System, and Blood Pool and associated pumpback system.

Elevations in the MA range from 1,036 m (3,400 ft) above mean sea level at the northern end to 730 m (2,400 ft) at the southern end. The Midnite Mine area has a continental climate characterized by warm, dry summers and moderately moist, cold winters.

Since the mining operations stopped, the Bureau of Indian Affairs (BIA) and the U.S. Bureau of Land Management (BLM) have been actively involved in planning the remediation and restoration of the site. In addition to BIA and BLM, other stakeholders include the Spokane Tribe of Indians (STI), the U.S. Department of the Interior (DOI), the U.S. Fish and Wildlife Service (FWS), the Washington State Department of Health (WSDH), the U.S. Environmental Protection Agency (EPA), and the DMC.

In 1995, the BLM, as the primary federal agency managing the lease after the mine closed, initiated scoping for an Environmental Impact Statement (EIS) for mine reclamation under the National Environmental Policy Act (NEPA). The EPA participated in this process, requesting that elements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) be incorporated.

SECTION A

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Following the scoping phase, BLM and EPA negotiated with Dawn Mining Company and Newmont Gold Inc. for completion of site studies and reclamation or cleanup. Concurrently, EPA completed an expanded site investigation to support the potential listing of the site on the National Priorities List (NPL). Although the mining companies agreed to conduct limited work in a 1998 agreement with BLM, negotiations for a comprehensive study and site reclamation, addressing CERCLA requirements, failed. EPA proposed the site to the National Priorities List (NPL) in February 1999 and began work on a CERCLA Remedial Investigation/Feasibility Study (RI/FS). In accordance with EPA Data Quality Objectives guidance, preliminary scoping of RI/FS data needs was completed by early June 1999, separated into two phases of work.

The RI/FS will be conducted in a phased approach to optimize the utility of data as they become available and maximize efficiency. Phase 1A, which is the focus of this workplan, will address physical and chemical characterization of groundwater, surface water, and stream sediment in the PIA, and characterization of background conditions for those same media. Phase 1A will be conducted in late 1999 and early 2000. Additional characterization of groundwater, surface water, and stream sediment in the PIA and background areas, if necessary, will be conducted as Phase 1B, probably in late 2000 and 2001.

Phase 2A, to be initiated in 2000, will address all environmental media in the MA (i.e., groundwater, open pit surface water and sediment, surface and subsurface mine materials and soil (including direct exposure and irradiation, radon, and air particulates), soil pathways in the PIA (including direct exposure, external irradiation, and deposition of chemical and radionuclide particles), surface and subsurface soil background conditions, potential contamination associated with haul roads (including the Fort-Wellpinit Road), and off-site construction materials.

Other RI/FS activities to be conducted as information from Phases 1A and 2A becomes available may include:

- Site-wide and area-specific groundwater and surface water/sediment fate and transport modeling
- Open pit and backfilled pit geochemical modeling
- Baseline human health and ecological risk assessment
- Treatability and pilot testing

The FS phase of the RI/FS will evaluate remedial alternatives appropriate for this site. Activities that may be conducted during the FS Phase include:

- Development of remedial action objectives
- Update of ARARs
- Alternative specific field investigation
- Alternative specific predictive modeling

Additional phases will be addressed through the DQO process and subsequent work plans.

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Preliminary conceptual site models and decision flow charts for Phase 2A media have already been developed during the Phase 1A work efforts but will be updated and modified as the DQO process for Phase 2A is completed.

This Quality Assurance Project Plan (QAPP), which includes Appendix A - Sampling and Analysis Plan (SAP), describes Phase 1A of RI/FS field activities to be conducted in fall 1999.

A.5.2 Previous Investigations

Numerous studies and investigations have been performed at the Midnite Mine. A summary of the major previous studies for characterizing the site setting, site-related contaminants, and the potential for off-site migration of contaminants is provided below. A complete list of documents and studies compiled by Kelly Courtright of BLM can be found in Appendix A of the Midnite Mine ESI Report (E&E 1998).

A.5.2.1 DMC Annual Water Quality Reports

In 1979, the United States Geological Survey (USGS) was the mining supervisory agency for Midnite Mine (later replaced by BLM). USGS initiated a program of quarterly water quality monitoring at 17 surface water stations (seeps, drainages, ponds) and at a series of newly installed monitoring wells located within and south of the MA. The monitoring program has expanded since its inception to include monitoring wells that were installed after 1979 and additional surface water quality stations. Samples collected for the monitoring program are analyzed for general water chemistry parameters (pH, conductivity), inorganic elements, and radionuclides.

DMC currently conducts routine monitoring of groundwater and surface water quality.

A.5.2.2 United States Geological Survey

The USGS conducted a hydrologic study of the Midnite Mine in 1984-1985 (Sunioka 1989). The report presented results on the following topics:

- Water budget information for the Blue Creek basin
- Effects of mineralization within the mine boundary on surface water quality
- Water quality in the pollution control pond, Pit 3, and Pit 4
- Effects of mine drainage on Blue Creek and its tributaries prior to the installation of the water treatment plant
- Groundwater quality south of the mine
- Recommendations for water quality monitoring

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A.5.2.3 United States Bureau of Mines Hydrologic Study

In 1988, the U.S. Bureau of Mines (BOM) initiated a study at Midnite Mine to characterize the hydrogeology and hydrochemistry of the site area to assist in the development of remedial actions and a mine reclamation plan. The report, prepared as a progress report to BIA, contains information regarding the on-site mine wastes and site geological information (Marcy et al., 1994).

The studies conducted by BOM were designed to achieve the following objectives:

- Delineate the three-dimensional distribution of hydrostatic head at the mine site;
- Determine contaminant source areas and plausible migration pathways;
- Determine possible chemical mechanisms that could be responsible for the observed chemical characteristics of the water, and
- Provide information for the development of a reclamation plan.

Fifteen additional monitoring wells at seven locations and fourteen surface water monitoring locations were established for this study. The study period included in the report was from November 1989 to June 1990. Water levels were recorded at each of the wells and surface water monitoring stations. Water samples were analyzed for anions, cations, conductivity, pH, Eh, and trace metal constituents.

Conclusions from the study included the following statements (Riley et al., 1991):

- Groundwater elevations in the bedrock underlying the mine range from 3,171 feet above sea level (near the Hillside Dump) to 2,600 feet above sea level (near the South Spoils).
- Groundwater flow at the mine roughly follows surface topography, from north-northwest to south.
- Contaminated water is found mainly in the southern third of the mine. The poorest quality groundwater collected from the monitoring wells was from wells 89-3M and 89-4S.
- Surface locations (seeps) in the southern portion of the mine discharge water that is of worse quality than that found in any of the monitoring wells. Note that while this condition was true when the report (Riley et al. 1991) was written, more recent data contradicted this statement. See Section A.5.2.4.

A.5.2.4 U.S. Bureau of Mines Hydrologic and Geophysical Studies

The USBOM performed additional field investigation activities related to the groundwater flow system. These activities included:

- Slug testing of bedrock wells
- Review of historical water level data

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- Assessment of long-term water quality at the mine
- Geophysical investigation of groundwater flow paths

The conclusions from the study included:

- Water quality was stable within seasonal variability at most sampling locations
- Wells 89-3M and 89-4S exhibited water quality degradation over time. Concentrations for some chemical constituents at each of these wells exceed concentrations in surface water.
- Geophysical survey results indicate that the backfilled Pit 2 contributes to the recharge system for the West Drainage Seep.

A.5.2.5 USGS/BOM Inventory, Characterization, and Water Quality of Springs, Seeps, and Streams Study

In 1995, USGS, in conjunction with BOM, collected data on water bodies adjacent to or near the Midnite Mine. The study included an inventory and characterization of 11 springs, 15 seeps, 2 streams, and 4 boreholes in areas near the Midnite Mine not directly impacted by mining activities. Samples were collected from the water bodies during two separate field events in June and late July 1995.

In summary, the water samples collected had a near-neutral pH and relatively low concentrations of dissolved solids. Most trace element concentrations in the water samples were below analytical detection limits. However, suspended concentrations of Radium-226, Uranium-234, and Uranium-238 were generally elevated above regional levels, with maximum activities detected up to 500 picocuries per liter (pCi/L) (USGS 1996).

A.5.2.6 DMC Reclamation Plan

DMC originally submitted the Midnite Mine Reclamation Plan in July 1991. An updated version of the plan was submitted to BLM in June, 1996 (SMI 1996). The document presents a revised Reclamation Plan (the 1996 Plan) for the Midnite Mine which was formerly operated by Dawn Mining Company (DMC) under leases approved by the Bureau of Indian Affairs (BIA). The 1996 reclamation plan was prepared for DMC by Shepherd Miller Inc. (SMI), and supersedes the documents entitled "Midnite Mine Reclamation Plan" (SMI 1991a) submitted by DMC to the Bureau of Land Management (BLM) in July 1991 and "Supplements to the Midnite Mine Reclamation Plan" (SMI 1991), submitted to the BLM in August 1991.

The Plan incorporates data and information collected and developed by a variety of federal agencies, the Spokane Tribe of Indians (the Tribe), and DMC since the 1991 Plan was prepared. These data include (but are not limited to) surface water and groundwater quality data collected since 1991, data and information from U.S. Bureau of Mines (USBM) investigations characterizing the ore and protore, waste rock, site hydrogeology and geochemistry, and radiation levels at the site. These data also include the results of a seismic refraction survey

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conducted by DMC in 1995 and estimates of the reduction in radiation levels that would result from the planned reclamation.

The Plan also sets forth reclamation criteria not included in the 1991 Plan which serve as the basis for development of the reclamation plan as well as for subsequent development of detailed reclamation design and performance evaluation. Reclamation design and performance criteria and reclamation activities described in this Plan were based on currently available information.

A.5.2.7 Sampling in Support of a Conceptual Stratigraphic Model for Natural Unconsolidated Deposits Downgradient of Midnite Mine

During February 1998, a study was performed for the STI to characterize the thickness and hydrostratigraphy of unconsolidated geologic units south of the mine. The study involved the placement of 19 soil borings and included the collection of continuous core samples from the borings and chemical analyses of selected soil samples for heavy metals and radionuclides. The results of the chemical analyses are not presently available. The report concludes that the drainages south of the mine site are underlain by unconsolidated deposits ranging in thickness from 14 to approximately 18 feet; the stratigraphy of the unconsolidated deposits is complex and spatially variable, including layers of clay, gravel, and sand; the unconsolidated deposits contain groundwater; underlying the unconsolidated deposits are schist, calc-silicate, monzonite, and buried wastes; competent monzonite generally is overlain by a zone of weathered monzonite (Ecology and Environment, Inc. 1998).

A.5.2.8 Ecology and Environment Characterization of Surface Water, Sediment, Groundwater, and Soils

Ecology and Environment, Inc. (E&E) was tasked by the US EPA, Region 10 under the START Program to provide technical support for completion of an Expanded Site Investigation (ESI) at the Midnite Mine (Ecology and Environment, 1998). The ESI was conducted to: (1) provide data on potential contaminant sources and potential contaminant pathways; (2) gather information needed to evaluate if the site should be placed on the National Priorities List; and (3) alert the EPA to immediate threats to public health or the environment and assess whether early action/removal actions are appropriate for the site.

E&E collected twenty-four surface water samples and thirty-six sediment samples, installed six groundwater monitoring wells, and collected thirteen soil/waste samples from locations at or near the Midnite Mine and at background locations. Samples were analyzed for Target Analyte List (TAL) inorganic elements, uranium, and eight radionuclides.

Seven potential sources were sampled for the ESI. The sources were identified for sampling based on site operations history and the results of previous investigations. These sources include: Pit 3, Pit 4, PCP, Blood Pool, NPDES Outfall, eight piles of stockpiled ore and protore, and the South Spoils. Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)-regulated inorganic elements and radionuclides were detected in all on-site sources at Midnite Mine. Releases of these contaminants have occurred through discharges of

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groundwater through seeps and overland transport through runoff. Elevated concentrations of site-related inorganic elements and radionuclides were detected in surface water and sediments up to approximately 3.5 miles downstream of the site. Targets impacted by site-related contaminants included wetlands in the East Drainage and Blue Creek, Rainbow trout habitat in Blue Creek, and fisheries in Blue Creek. In addition, selected surface water quality benchmarks and groundwater standards were exceeded in many of the ESI samples.

A.5.2.9 Shepherd Miller Characterization and Water Quality of Streams Groundwater and Sediments Study

In September 1998, a work plan for a series of field investigations and studies at the Midnite Mine was prepared by Shepherd Miller, Inc. (SMI) on behalf of DMC and Newmont Gold Company. The work plan consists of five major elements:

- Radiological Characterization
- Materials Characterization
- Hydrologic Characterization
- Off-Site Migration Evaluation
- Reclamation and Treatment Evaluation

Implementation of the work plan began in fall 1998. Field data collection was expected to be concluded in June, 1999.

Surface water concentrations were similar to elevated sediment concentrations down gradient of the Midnite Mine along the western, central and eastern drainages. Additionally, there were elevated concentrations downgradient along Blue Creek which may indicate contaminant loading resulting from offsite tributaries not associated with the mining operations of the Midnite Mine.

A.5.2.10 Peters Geosciences Historical Aerial Photographs Evaluation

Doug Peters of Peters Geosciences has performed a detailed evaluation of historical aerial photographs of the Midnite Mine site (Peters 1999a). He has reviewed and orthorectified aerial photographs taken from various periods dating from 1950 to 1994. Based on the images, he has identified the locations of buried stockpiles, waste rock, soil piles, and other features. These features have been represented in digital form and have been incorporated into an ArcInfo GIS of the Midnite Mine.

As part of the aerial photograph evaluation, apparent stains around the mine were identified and tracked. The stains were usually connected to vehicles and likely represented spills of oil and other nonaqueous fluids. Many stains were transient and did not recur in later photographs. Some areas that appeared to be used repeatedly or continuously as shop or storage areas had recurring to continuous stains (Peters 1999b).

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A.5.3 Investigation Approach

Data and results of the previous investigations have been used in the development of the Phase 1A RI/FS field investigation. Based on prior mining operations, the site has been divided into three principal investigation areas, the Potentially Impacted Area (PIA), the Mined Area (MA), and Background Areas. The Phase 1A RI/FS field investigation presented in this document addresses only the characterization of groundwater, surface water and sediment in the PIA and Background Areas.

The PIA has been divided into nine Areas of Interest (AOIs) corresponding with potentially impacted drainages or ridges surrounding the MA. The PIA consists of the following AOIs: Western Drainage, Central Drainage, Eastern Drainage, Northeastern Drainage, Northern Drainage, Northwest Ridge, Far West Drainage, Southwestern Drainage, and Blue Creek (Figure A.5.1-2).

The data quality objectives for surface water, sediment, and groundwater pathways in the PIA and Background Areas are discussed in Section A.7 and in Tables A.7.2-2 and A.7.2-3. Each table details the problem statement; the decision statement; the study area boundary; required inputs to the decision; the type, locations, and number of samples necessary to make decisions; the chemical groups to be analyzed for; and the rationale behind the data needs identified for each AOI.

A.6 PROJECT DESCRIPTION AND SCHEDULE

A.6.1 Description

URSG has prepared this QAPP on behalf of EPA for the Midnite Mine site. The QAPP has been prepared in accordance with EPA Region 10 Expanded QAPP Guidance for Superfund Lead Projects (EPA, 1998d) and EPA Requirements for Quality Assurance Project Plans (EPA, 1998b). The QAPP, which contains the sampling and analysis plan and standard operating procedures, provides the direction and procedures for implementing the Phase 1A RI/FS field investigation for Midnite Mine. The Phase 1A RI/FS field investigation involves characterization of groundwater, surface water, and sediment in the PIA and in Background Areas. Data are being collected to satisfy the data needs identified during the DQO process and summarized in Tables A.7.2-2 and A.7.2-3. Data are needed to:

- Evaluate the potential migration of PCOCs in groundwater, surface water and sediment from the MA to the PIA
- Identify the nature and extent of contamination in groundwater, surface water, and sediment in the PIA
- Provide data for baseline risk assessments and the feasibility study

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- Characterize background PCOC concentrations in groundwater, surface water and sediment, and
- Evaluate whether additional sampling is needed.

Phase 1A RI/FS field investigation activities include:

- Premobilization
- Laboratory procurement
- Mobilization
- Well installation and logging
- Surface water/sediment sampling and surface water flow measurement
- Monitoring well development and sampling
- Surveying
- Demobilization
- Laboratory analysis

Details of the field activities are provided in the Appendix A SAP.

A.6.2 Schedule

An estimated schedule for the planning and Phase 1A field investigation activities is shown on Figure A.6.2-1. The field activities starting with Premobilization are estimated to begin following review and approval of the QAPP. Mobilization of field staff and drilling subcontractors should begin by September 1. Field activities would continue through the end of October. Laboratory analysis is expected to be completed by the end of May 2000. The schedule for the Phase 1A field investigation activities is dependent on review and approval of the final QAPP.

A.7 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

A.7.1 Purpose/Background

This section addresses the data quality objectives (DQOs) process applied in development of the Midnite Mine Phase 1A RI/FS QAPP. The DQO process is a systematic planning tool based on the Scientific Method for establishing criteria for data quality and for developing data collection designs. Establishing formal DQOs during the QAPP stage of a project allows clear and unambiguous definition of project objectives, decisions, and decision criteria so that data of sufficient type, quality, and quantity are generated to meet project objectives. The formal implementation of a DQO process brings structure to the planning process, thereby resulting in defensible decision making.

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The U.S. Environmental Protection Agency's Guidance for the Data Quality Objectives Process (EPA QA/G-4, Final, September 1994a) was referenced in implementing the DQO process for the Phase 1A RI/FS QAPP. That document, which is intended to provide general guidance on developing data quality criteria and performance specifications for decision making, addresses application of the U.S. EPA's seven step DQO process for site investigations.

A.7.2 Specifying Quality Objectives

This section provides the output from the DQO process applied for the Phase 1A RI/FS. Phase 1A of the RI/FS focuses on groundwater, stream surface water, and stream sediment in the PIA and Background Areas. The PIA is the area outside of, but potentially impacted by, the MA, where mining activities were historically conducted. The MA has also been referred to as the Disturbed Area in previous studies.

For the Phase 1A RI/FS QAPP, the PIA has been divided into nine AOIs (Table A.7.2-1). These AOIs consist of the surface drainages or ridges that surround and are potentially impacted by the MA. The locations of the PIA AOIs are shown on Figure A.7.2-1.

The output of the DQO process for each PIA AOI is summarized on Table A.7.2-2. The output of the DQO process for the background characterization is summarized on Table A.7.2-3.

A.7.2.1 DQO Step 1: Statement of the Problem

The purpose of Step 1 is to “*clearly define the problem so that the focus of the study will be unambiguous.*” (EPA, September 1994a). A summary of the groundwater, surface water, and sediment contamination problem for the PIA is:

Historical mining activities conducted in the MA have resulted in releases of materials known to contain PCOCs. Migration of PCOCs to the PIA from the MA appears to have occurred in downgradient drainages south of the MA (i.e., the Western, Central, and Eastern Drainages). However, the nature and extent of contamination or the degree of risk to humans or the environment posed by the PCOCs have not been adequately evaluated.

It may be possible that migration of PCOCs from the MA to the PIA has also occurred to drainages east, northwest, west, and southwest of the MA. This possibility has not been adequately evaluated.

Future releases from the MA to the PIA may also be possible. These future releases may result in migration of contamination to previously unaffected areas, or worsening of water or sediment quality in affected areas. Additional evaluation of this possibility is necessary.

Because this is an area of natural mineralization, naturally-occurring inorganic PCOCs may occur at levels exceeding Applicable or Relevant and Appropriate Requirements (ARARs) or acceptable risk levels even in the absence of mine effects. Therefore, pre-mining background levels of naturally-occurring inorganic PCOCs must be estimated to allow evaluation of whether potentially affected areas have indeed been affected by the MA.

Problem definitions for each PIA AOI are provided on Tables A7.2-2 and A7.2-3.

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A.7.2.1.1 Identification of Current and Future Land Use in the PIA

One of the important components of the problem statement is identification of the current and future land use. An understanding of current and future land use is necessary to understand how the contamination problem may affect humans or the environment. For the Phase 1A RI/FS, current and reasonably anticipated future land use scenarios for the PIA AOIs have been established in consultation with the STI. These land use scenarios are discussed in Sections A.7.2.1.3 and A.7.2.1.4.

A.7.2.1.2 Description of the PIA

Portions of the PIA located adjacent to the MA are forested, with occasional open parks typical of the foothills sections. The vegetation community type for the Midnite Mine area is the ponderosa pine/Idaho fescue/bluebunch wheatgrass association (SMI 1996). Vegetation is more dense in and around the drainages and Blue Creek. (Detailed information on the environmental resources of the Blue Creek drainage and Spokane Indian Reservation, including the PIA, is available in several documents: Zamora 1983; Stinson and Gilbert 1985; Doughtie et al. 1993; Peone et al. 1993; DOE 1994; CSU 1996.)

Drainages in seven of the AOIs in the PIA receive runoff from the MA: Western, Central, Eastern, Northeastern, Northern, Far West, and Southwestern Drainages. A small portion of the Northwest Ridge also receives runoff from a small portion of the MA. Blue Creek ultimately receives water and sediment from the drainages surrounding the MA (except Sand Creek). In addition, Blue Creek receives water and sediments from Turtle Lake (the original source to Blue Creek), Oyacken Creek southwest of the PIA, and several small unnamed tributaries upstream of the PIA. Blue Creek flows to Franklin D. Roosevelt Lake, approximately 4.5 miles from the site.

A.7.2.1.3 Current Land Use in the PIA

Land in the PIA is primarily used by STI members to support a traditional lifestyle that includes subsistence, cultural/spiritual, and medicinal components. This type of land use is very specific to the STI, and is not well reflected by typical CERCLA categories of human land use (e.g., residential, commercial, recreational, hunting, fishing). Additional information on current land use in the PIA is provided below.

Hunting/Gathering

The primary current land use in the PIA is hunting/gathering by members of the STI to support a traditional lifestyle. The PIA is owned by the STI and each member of the tribe may hunt, fish, or gather anywhere in the PIA.

Hunting and gathering are done on a regular basis to keep the extended family unit stocked with a wide variety of aquatic and terrestrial wild plants and wildlife used for subsistence, cultural/spiritual, and medicinal purposes. While in the field, tribal members live off the land by consuming surface water and groundwater (from seeps/springs) and using wild plants and wildlife for subsistence, cultural/spiritual, and medicinal purposes.

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Cultural/Spiritual Ceremonies

Parts of the PIA may be used by members of the STI for conducting cultural/spiritual ceremonies, such as sweat lodge ceremonies. Sweat lodges are constructed of natural materials (i.e. branches, moss, leaves) near a source of surface water or groundwater. Sweat lodges that use groundwater have spiritually different significance than those constructed near sources of surface water. There are no groundwater wells located in the PIA. However, groundwater in the PIA from seeps/springs could currently be used for sweat lodge ceremonies. In addition, sweat lodge ceremonies using surface water could currently be conducted in the PIA.

A Children's Culture Camp for cultural education is held at the Blue Creek Campground in the PIA for a portion of each summer.

Livestock Foraging

Most livestock owned by the STI are free to forage throughout the reservation (i.e., the livestock are not fenced in). Therefore, the PIA may be occasionally used by livestock for foraging.

Recreational Use

The STI owns a campground and beach (Blue Creek Campground) used primarily for recreation, located at the confluence of Blue Creek and Roosevelt Lake, 4.5 miles from the MA. In addition, other parts of the PIA may be used by members of the tribe for recreational purposes.

Field Work

Environmental workers (typically members of the STI) currently perform field work in the PIA (e.g., touring the site, collecting environmental samples).

Residential

The nearest occupied residence is located approximately 4.8 kilometers from the MA (SMI 1999), which is outside the anticipated extent of the PIA. Therefore, the PIA is not currently believed to be used for residential purposes.

Groundwater Use

Groundwater from wells is not currently used for water supply or cultural/spiritual purposes in the PIA, because there are no groundwater supply wells located in the PIA. However, groundwater from seeps/springs in the PIA could currently be used for drinking water and cultural/spiritual purposes.

A.7.2.1.4 Reasonably Anticipated Future Land Use in the PIA

Future land use in the PIA is expected to remain similar to current land use, in that land will primarily be used for traditional purposes (subsistence, cultural/spiritual, medicinal) and for

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livestock foraging. In addition, future residential and industrial use of land in the PIA are possibilities. The current infrastructure (electrical power, septic facilities, buildings, parking areas) in the MA adjacent to the PIA make the PIA a good location for future residential and industrial use. Residences could be built on parcels of land in the PIA currently owned by individual members of the STI.

Groundwater from wells could be used in the future for water supply in a residence or industrial building or for cultural/spiritual purposes, if water supply wells are established in the PIA.

A.7.2.1.5 Conceptual Site Model

Similar to current and future land use, another of the important components of the problem statement is development of a conceptual site model (CSM). A CSM is a schematic representation of the chemical source areas, chemical release mechanisms, environmental transport media, potential exposure routes, and potential receptors. The purpose of the CSM is to (1) represent chemical sources and exposure pathways that may result in human health or ecological risks, (2) aid in developing a sampling plan to address significant chemical release and migration pathways, and (3) aid in identifying effective remediation alternatives, if necessary, that are targeted at key exposure pathways. An understanding of the CSM is critical in understanding the mechanisms by which the contamination problem may affect humans or the environment. For the Phase 1A RI/FS, the preliminary human health and ecological CSMs for the PIA AOIs have been established in consultation with the STI.

Only complete exposure pathways are evaluated in risk assessment. A complete exposure pathway includes all of the following elements:

- A source and mechanism of contaminant release
- A transport or contact medium
- An exposure point where humans or ecological receptors can contact the contaminated medium
- An exposure (intake) route (such as ingestion or inhalation)

The absence of any one of these elements results in an incomplete exposure pathway. Where there is no potential human or ecological exposure, there is no potential human health or ecological risk.

Similarly, EPA's risk assessment and risk characterization guidance does not require that all complete exposure scenarios and pathways be quantitatively assessed. Quantitative assessment (if feasible) is recommended for potentially complete and significant pathways. Exposure pathways that are potentially complete, but insignificant are evaluated qualitatively.

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A.7.2.1.6 Human Health Conceptual Site Model (CSM)

A.7.2.1.6.1 *Potential Receptors in the PIA*

Based on current and likely future human land use scenarios, potential receptors in the PIA could include traditional hunter/gatherers, workers (industrial, environmental, forestry), residents, recreational users, trespassers, and others. EPA guidance does not require that all exposure scenarios be evaluated in the human health risk assessment. Instead, EPA recommends evaluating the receptors that are likely to have the most exposure (e.g., the "most exposed" receptors). Based on consideration of various potential exposure scenarios in the Midnite Mine area, three scenarios were developed that likely represent the greatest exposure: current residents of the reservation who are assumed to visit the PIA, future residents of the reservation who are assumed to live in the PIA, and future industrial workers who are assumed to work in buildings in the PIA. These receptor scenarios are discussed in more detail below.

Current Residents Of The Reservation

Current residents of the reservation are members of the STI who are assumed to live a traditional lifestyle that has significant subsistence, cultural/spiritual, and medicinal components. These current residents of the reservation are assumed to visit the PIA frequently for the purposes of hunting/gathering, cultural/spiritual ceremonies, work, and recreation, but do not to live in the PIA (there currently are no residences in the PIA). It is important to note that this traditional lifestyle is very specific to the STI, and is not well reflected by typical CERCLA receptor scenarios (e.g., residential, commercial, recreational, hunting, fishing).

Hunting/gathering to support subsistence, cultural/spiritual, and medicinal needs is the traditional way of life for members of the STI. Hunting and gathering is based on the needs of members of the STI, rather than on legal limits (e.g., there are no limits on numbers of fish caught from the PIA). Big game and fish are not the only wildlife consumed. The traditional diet for the tribe includes small mammals, insects, grubs, frogs, and other wildlife.

Different portions of each plant and animal are used for traditional purposes. For example every portion of big game such as deer, elk, bear, cougar, or wolverine, and of livestock is used for specific subsistence, cultural/spiritual, or medicinal purposes. Portions of plants are harvested as needed (e.g., roots, flowers, and leaves are harvested without destroying the plant, allowing for future root growth) and used for subsistence, cultural/spiritual, or medicinal purposes.

Medicinal uses of plants can include direct ingestion, dermal applications, subdermal application in open cuts, and inhalation (including smoking).

Hunting and gathering by current members of the reservation often involves the extended family unit, including children of all ages. All members work in the field on a regular basis to keep the extended family unit stocked. While in the field, members of the STI live off the land by consuming water, wild plants, and wildlife (AESE 1999). There are currently no groundwater supply wells located in the PIA. However, surface water and groundwater from seeps/springs may be used as drinking water sources during visits to the PIA.

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Current residents of the reservation are assumed to conduct cultural/spiritual ceremonies in the PIA, including sweat lodge ceremonies. For members of the STI, the sweat has highly spiritual and medicinal significance. For medicinal purposes, it is vital that the natural environment is clean and free of contaminants. Water used in sweat lodge ceremonies by current residents could include surface water and groundwater from seeps/springs.

The STI owns a campground and beach (Blue Creek Campground) used primarily for recreation, located at the confluence of Blue Creek and Roosevelt Lake, 4.5 miles from the mined area. A Children's Culture Camp is held at the Blue Creek Campground for a portion of each summer. Other parts of the PIA may be used by members of the tribe for recreational purposes.

Some current residents of the reservation occasionally perform environmental work in the PIA.

Future Residents of the Reservation

The future residents of the reservation are assumed to live in the PIA and to follow a traditional lifestyle similar to that described in the previous section for current residents of the reservation (i.e., in addition to living in the PIA, future residents of the reservation are assumed to use the PIA for hunting/gathering of wild plants and wildlife, for cultural/spiritual ceremonies, and for recreational purposes).

It is assumed that groundwater from wells in the PIA will be used by future residents of the reservation for domestic and cultural/spiritual purposes (if water supply wells are established in the PIA).

Future Industrial Workers

Future industrial workers are assumed to work primarily indoors in buildings in the PIA (there currently are no buildings in the PIA). It is assumed that groundwater from wells in the PIA will be used for water supply by future industrial workers (if water supply wells are established in the PIA).

A.7.2.1.6.2 Preliminary Human Health CSMs

Preliminary human health CSMs were developed for two potential sources of contamination. Figure A.7.2-2 is the preliminary human health CSM for groundwater and seeps/springs located in the MA and PIA. Figure A.7.2-3 is the preliminary human health CSM for surface water and sediments in the drainages and Blue Creek located in the PIA.

Human Health Conceptual Site Model for Groundwater and Seeps/Springs in the PIA

The primary potential sources of constituents in groundwater in the MA are from surface water in the open pits and surface and subsurface material in the MA. Constituents in the MA may have been transported to groundwater in the MA via:

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- leaching of inorganics from the waste/ore/protores stockpiles and backfilled pits
- leaching of petroleum constituents or solvents from surface and subsurface materials (limited to areas where mine vehicles were maintained or parked)
- discharge of surface water from the open pits

Groundwater in the MA is the primary potential source of constituents to seeps/springs and groundwater in the PIA. Constituents in groundwater in the MA may have been transported to seeps/springs in the PIA via groundwater discharge and to groundwater in the PIA via groundwater flow.

As indicated in Figure A.7.2-2, the potential release mechanisms for transporting constituents from groundwater include downgradient groundwater flow; infiltration of radon and daughter products and VOCs through a foundation into indoor air in a residence or industrial building; and emission of radon and daughter products and VOCs to indoor air from indoor use of groundwater in a residence, industrial building, or sweat lodge; and uptake of groundwater by phreatophytes in the riparian zone. Potentially impacted media in the PIA include groundwater; indoor air in future residences, industrial buildings, or sweat lodges; and phreatophytes.

Potential release mechanisms for transport of constituents in seeps/springs include discharge to surface water in the PIA; active pumping of water to the water treatment plant followed by discharge to surface water in the PIA; emission of radon and daughter products from seeps/springs to ambient air and to indoor air (in a sweat lodge ceremony); and uptake of constituents by terrestrial wildlife and livestock. Potentially impacted exposure media include water in seeps/springs, ambient air, terrestrial wildlife, livestock, and indoor air in a sweat lodge.

Potentially Complete and Significant Exposure Pathways for Groundwater and Seeps/Springs in the PIA

Receptors identified for the PIA are current and future residents of the reservation and future industrial workers.

Potentially complete and significant exposure pathways by which current residents of the reservation could be exposed in the PIA are:

- Ingestion and dermal contact with seeps/springs in the PIA
- Ingestion, dermal, and inhalation exposure to seep/spring water in a sweat lodge in the PIA (containing steam from the water)
- Ingestion and dermal exposure to livestock and terrestrial wildlife that may have been impacted by ingesting water from seeps/springs in the PIA. The potential significance of this pathway depends on the percentage of total water consumed by livestock and terrestrial wildlife that is from seeps and springs in the PIA. For example, this pathway could be significant if future use of the PIA included corrals where seeps/springs were used to water livestock, or if seeps/springs were the only source of water to terrestrial wildlife during the driest parts of the year.

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- Ingestion, dermal, and inhalation exposure to phreatophytes. Dermal exposure could include subdermal exposure following application to open wounds.

Potentially complete and significant exposure pathways by which future residents of the reservation could be exposed in the PIA are:

- Ingestion, dermal, and inhalation exposure to groundwater from a well during ceremonies in a sweat lodge in the PIA (containing steam from groundwater)
- Ingestion and dermal exposure to groundwater from a well during domestic use in a residence in the PIA
- Inhalation of indoor air containing constituents from groundwater from a well in the PIA (from domestic use or infiltration through a foundation)
- Ingestion and dermal contact with seeps/springs in the PIA
- Ingestion, dermal, and inhalation exposure to seep/spring water during ceremonies in a sweat lodge in the PIA (containing steam from the water)
- Ingestion and dermal exposure to livestock and terrestrial wildlife that may have been impacted by ingesting water from seeps/springs in the PIA. The potential significance of this pathway depends on the percentage of total water consumption by livestock and terrestrial wildlife that is from seeps and springs in the PIA. For example, this pathway could be significant if future use of the PIA included corrals where seeps/springs were used to water livestock, or if seeps/springs were the only source of water to terrestrial wildlife during the driest parts of the year.
- Ingestion, dermal, and inhalation exposure to phreatophytes. Dermal exposure could include subdermal exposure following application to open wounds.

Potentially complete and significant exposure pathways by which future industrial workers could be exposed in the PIA are:

- Ingestion of groundwater from a well
- Inhalation of indoor air containing constituents from groundwater (from infiltration through a foundation)

Incomplete or Potentially Complete, but Insignificant Exposure Pathways For Groundwater and Seeps/Springs in the PIA

EPA's risk assessment and risk characterization guidance does not require that all plausible exposure scenarios and exposure pathways be assessed. Quantitative assessment (if feasible) is recommended for potentially complete and significant pathways. Exposure pathways that are potentially complete, but insignificant will be evaluated qualitatively. Exposure pathways that are incomplete (i.e., where no exposure is possible) will not be evaluated.

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The following exposure pathways have been identified on the human health CSM as incomplete for the current residents of the reservation:

- Ingestion, dermal, and inhalation exposure to groundwater from wells is an incomplete pathway for current residents of the reservation because there are currently no groundwater supply wells in the PIA.

The following exposure pathways have been identified on the human health CSM as potentially complete, but insignificant for current and future residents of the reservation because exposure and risk are likely low:

- Inhalation of radon and daughter products emitted from seeps/springs in the PIA into ambient air is a potentially complete pathway for human receptors. However, this pathway is likely insignificant for human receptors because the seeps/springs source areas are small relative to the overall exposure area for ambient air.

Human Health Conceptual Site Model for Surface Water and Sediments in the PIA

The primary potential source of constituents to surface water and sediments in the PIA is the MA. Constituents in the MA may have been transported to surface water and sediments in the PIA via:

- stormwater runoff of surface material from the MA
- discharge of groundwater and seeps/springs from the MA
- overflow of surface water from the open pits in the MA
- discharge from the water treatment plant in the MA

In addition, constituents in the PIA may have been transported to surface water and sediments in the PIA via:

- stormwater runoff of surface material from the Haul Road and the PIA

As indicated in Figure A.7.2-3, the potential release mechanisms for transporting constituents from surface water and sediments in PIA include surface water flow to downstream areas; wind suspension of sediment particulates; emission of radon and daughter products from surface water and sediments to ambient air and from surface water to indoor air (in a sweat lodge ceremony); and uptake of constituents by aquatic plants, aquatic and terrestrial wildlife, and livestock. Potentially impacted exposure media include surface water; sediments; ambient air; aquatic plants; aquatic and terrestrial wildlife; livestock; and indoor air in a sweat lodge.

Potentially Complete and Significant Exposure Pathways For Surface Water and Sediments in the PIA

Receptors identified for the PIA are current and future residents of the reservation and future industrial workers. Potentially complete and significant exposure pathways by which current and future residents of the reservation could be exposed are:

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- Incidental ingestion and dermal exposure to surface water and sediments via wading in the drainages and Blue Creek (e.g., for the purposes of hunting/gathering, cultural/spiritual ceremonies, work, and recreation). Dermal exposure to sediments could include subdermal exposure following application to open wounds.
- Intentional ingestion of surface water as a drinking water source
- Ingestion, dermal, and inhalation exposure to surface water in a sweat lodge
- Ingestion of parts of aquatic plants from the PIA for subsistence, cultural/spiritual, and medicinal purposes. There may also be dermal exposure to parts of aquatic plants applied to the skin, subdermal exposure to parts applied to open wounds, and inhalation exposure to parts of aquatic plants that are burned or smoked, each for cultural/spiritual or medicinal purposes.
- Ingestion of aquatic wildlife in the PIA and terrestrial wildlife and livestock that may have been impacted by surface water and sediments in the PIA. There may also be dermal exposure to parts of wildlife and livestock that are applied to the skin for cultural/spiritual or medicinal purposes.
- External irradiation exposure and inhalation of particulates and radon and daughter products emitted by dried sediments during recreational use of the beach at the Blue Creek Campground.

There are no complete pathways for exposure of industrial workers to surface water or sediments in the PIA.

Potentially Complete, but Insignificant Exposure Pathways For Surface Water and Sediments in the PIA

The following exposure pathways have been identified on the human health CSM as potentially complete, but insignificant because exposure and risk are likely low:

- External irradiation from sediments is a potentially complete pathway for receptors visiting drainages and Blue Creek in the PIA. However, this pathway is likely insignificant for human receptors at most parts of the PIA because the surface water will greatly reduce external irradiation emitted by bottom and suspended sediments, and the source area is small for external irradiation emitted from dried sediments.
- Inhalation of particulates emitted from dried sediments in the drainages and Blue Creek is a potentially complete pathway for receptors who visit drainages in the PIA. However, this pathway is likely insignificant for human receptors in most parts of the PIA because the source area is small for exposed dried sediments.
- Inhalation of radon and daughter products emitted from surface water and sediments into ambient air is a potentially complete pathway for receptors who visit drainages and Blue Creek in the PIA. However, this pathway is likely insignificant for human receptors in most

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parts of the PIA because the surface water and sediment source areas are small relative to the overall exposure area for ambient air.

As discussed in the previous section, external irradiation exposure and inhalation of particulates and radon and daughter products emitted by dried sediments at the beach at the Blue Creek Campground are each considered potentially complete and significant because the beach is a potentially large source area and the potential for exposure from recreational use is high.

A.7.2.1.7 Ecological Conceptual Site Model (CSM)

Developing the ecological risk assessment (ERA) CSM requires a different set of considerations than those needed to develop the human health model. As the ERA process at Midnite Mine is only in the preliminary planning stages, decision flow charts specific to the ERA process are still under development. The preliminary ecological CSMs presented in this section were largely based on professional judgement and standard model components. Further iterations to this model are expected during the planning/problem formulation process and during development of the forthcoming ERA Workplan. Proposed methods (e.g., total, incremental) for conducting the risk analysis portion of the ERA will also be identified in the Workplan.

Developing the Ecological CSM for Midnite Mine

The ecological CSM is a powerful learning and communication tool and an important component of the ERA planning process. The ecological CSMs provide an explicit expression of the assumptions and understanding of the ecosystem for others to evaluate. The ecological CSM provides the framework for prediction and the template for generating risk hypotheses: i.e., predicted relationships among stressor, exposure, and assessment endpoint response.

Risk hypotheses are proposed answers to questions risk assessors have about what response assessment endpoints will show when they are exposed to stressors and how exposure will occur. As only a small, limited number of assessment endpoints can be addressed and these have yet to be identified at Midnite Mine, risk hypotheses are initially formulated using a combination of professional judgement and knowledge of the ecosystem at risk. Risk hypotheses are not conditional on quantification or validation, nor are they equivalent to statistical testing of null and alternative hypotheses (EPA 1998). Predictions generated from these risk hypotheses eventually become the focus of the risk analyses effort. Given the infinite number of possible risk predictions at Midnite Mine, only those predictions judged to be essential to the overall RI/FS decision process will be considered for future quantitative or qualitative evaluation.

Conceptual models account for one of the most important sources of uncertainty in a risk assessment. If important ecological relationships are missed or specified incorrectly, the risk characterization may misrepresent actual risks. Uncertainty arises from the fundamental lack of knowledge about how ecosystems function, failure to identify and to interrelate temporal and spatial parameters, omission of stressors, or overlooking stressor effects. In some cases, little is known or data are lacking on how a stressor moves through an ecosystem or causes adverse effects, as is the case with radionuclides in ecological systems (Hinton and Whicker 1997). Because simplification and lack of knowledge are unavoidable, the ultimate goal of the

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ecological CSM is not to identify and quantify as many exposure pathways as possible, but rather to document what is known and rank model components in terms of uncertainty and potential significance (i.e., effectiveness as far as improving remedial or risk management decision-making).

The models presented below are expected to evolve, as they are iteratively and continuously evaluated throughout the ERA planning/problem formulation process and ERA Workplan development. Further planning discussions will likely be held to ensure that the appropriate balance of requirements for this ERA process is established.

Preliminary Ecological Conceptual Site Model

The preliminary ecological CSMs for the groundwater and surface water/sediment pathways are presented in Figures A.7.2-4 and A.7.2-5. Figure A.7.2-4 illustrates the exposure pathways for groundwater, seeps, and springs. Figure A.7.2-5 illustrates exposure pathways for surface water and sediment in the PIA. Both CSMs trace the movement of chemical and radiological contaminants through the environment from sources to ecological receptors. Contaminant sources, release mechanisms, exposure pathways, and exposure points are the same as those described for human exposure in Section A7.2.1.6.

Exposure Media

Potential exposure media for ecological receptors include groundwater, downgradient seeps and springs that originate from groundwater (Figure A.7.2-4), and downgradient surface water and sediments (Figure A.7.2-5).

Receptors

Ecological receptors that may be exposed to contaminants in seeps, springs, surface water, and sediment are both terrestrial and aquatic. Within the terrestrial ecosystem, two principal categories of receptors are potentially exposed – primary producers (plants) and consumers (animals). Riparian and wetland vegetation are the primary terrestrial producers where herbivores, omnivores, and carnivores are the primary consumers.

Similarly, in the aquatic ecosystem (PIA surface water and sediment, Figure A.7.2-5), representatives of both the primary producer and consumer categories may be exposed. Primary producers include rooted aquatic plants and attached algae. Animal consumers that may be exposed include aquatic invertebrates and fish in addition to the birds and mammals that feed on fish and aquatic invertebrates.

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Exposure Routes

The ecological receptors described above may be exposed to contaminants through two primary pathways – direct contact (animal ingestion and plant uptake) and food-chain exposure. Secondary pathways include contaminant inhalation and external irradiation.

Although there is no direct exposure of wildlife ecological receptors to contaminants in groundwater, there is the potential for indirect exposure. Wetland plants and phreatophytes, long rooted plants that may absorb much of their water from the water table, may be directly exposed to groundwater and subsequently ingested by wildlife. Groundwater discharge expressed on the surface as seeps or springs can also potentially result in contaminant exposure (Figure A.7.2-4). While exposure at seeps or springs is possible and may be significant for some individuals, such exposure is unlikely to be significant for wildlife populations because the exposure areas are intermittent and spatially limited. Unless the receptor is a threatened or endangered species, populations, and not individuals, are the receptor (assessment endpoint) in an ERA. Because of the limited exposure opportunities for wildlife populations at seeps or springs, risk evaluations of these exposure pathways likely would be qualitative. This assumption does entail uncertainty as there may be cases where small but disproportionally important functional groups or specific populations of concern are exposed. This consideration will be considered further as part of the assessment endpoint identification process. Wildlife contaminant exposure via the inhalation pathway is usually considered to be of little concern for any contaminant relative to the ingestion and food chain exposure pathways.

PCOCs of ecological concern in PIA surface water and sediment (Figure A.7.2-5) can originate from three sources – overland (stormwater) transport from the MA and PIA, overflow of water from the open pits in the MA, and discharge from groundwater to surface water directly or through seeps and springs. The primary exposure pathways to PIA surface water and sediment are direct contact via wildlife ingestion and plant uptake. Wildlife consumers in both aquatic and terrestrial ecosystems could also be exposed through ingestion of food items (plants or lower-level animals) that were exposed through direct contact. The food-chain exposure pathway is not applicable to plants. Pathways of less concern include: external irradiation from sediment and surface water, and fugitive dust from dried sediments. These latter exposure pathways will likely be evaluated qualitatively; particularly where modeling efforts would be inappropriate or unfeasible due to the lack of obtainable data, or overriding fundamental uncertainties.

The preliminary ecological CSMs in Figures A.7.2-4 and A.7.2-5 will be further evaluated, refined, and potentially expanded in the future to include details on ecological pathways, exposure points, and food-chain relationships that are identified during Phase 1A field investigations. The refined ecological CSM may have additional sources, exposure pathways, or ecological receptors; the significance of individual pathways may be modified depending on their usefulness for decision-making; or pathways may be eliminated if they are judged to not be significant in light of new information or project decisions.

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A.7.2.2 DQO Step 2: Decision Statements

The purpose of Step 2 is to “*define the decision statement that the study will attempt to resolve.*” (EPA, September 1994a). The objective of the RI/FS process is to gather sufficient information to support an informed risk management decision regarding the need for and, if needed, the most appropriate remedy for a given site (EPA 1988). The primary objectives of the RI/FS are:

- Determine whether historic mining activities conducted at the Midnite Mine have resulted in release of contamination to environmental media that poses an unacceptable risk to human health or the environment, or violates ARARs, and;
- If such a release has occurred, select an appropriate environmental remedy or remedies to reduce risks to acceptable levels and achieve compliance with ARARs.

Figures A.7.2-6 and A.7.2-7 depict the remedial investigation (RI) Decision Flow Charts (DFCs) for the Phase 1A RI/FS for groundwater, surface water, and sediment in the PIA. Figure A.7.2-8 depicts the feasibility study (FS) DFC. The DFCs address the following fundamental types of decisions:

Decision 1 (Figures A.7.2-6 and A.7.2-7): Are exposure pathways associated with ground water, surface water, or sediment in the PIA potentially complete and significant for humans or the environment, or are there ARARs associated with the media?

Decision 2 (Figures A.7.2-6 and A.7.2-7): Have historic mining activities affected groundwater, surface water, or sediment in the PIA at levels above background concentrations?

Decision 3 (Figures A.7.2-6 and A.7.2-7): Have historic mining activities contaminated groundwater, surface water, or sediment in the PIA at levels that pose an unacceptable risk or fail to comply with ARARs, thereby requiring a remedy or remedies?

Decision 4 (Figures A.7.2-6 and A.7.2-7): Will groundwater, surface water, or stream sediment in the PIA have the potential to be contaminated in the future, thereby requiring a remedy or remedies?

Decision 5 (Figure A.7.2-8): What is/are the preferred remedy/remedies for groundwater, surface water, or sediment in the PIA?

Table A.7.2-2 identifies the decisions to be resolved for each of the PIA AOIs.

A.7.2.3 DQO Step 3: Identify the Inputs to the Decision

The purpose of Step 3 is to “*identify the informational inputs that will be required to resolve the decision statement and determine which inputs require environmental measurements.*” (EPA, September 1994a).

Decisions 1 through 4 identified above are focused on determining whether a release of contamination to the PIA has occurred or will occur, and estimating the risk to humans and the environment from such a release. The types of information needed to support resolution of these decisions include:

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- Potential exposure pathways and receptors (including an assessment of current and future land use)
- Preliminary ARARs for groundwater and surface water
- Maximum or 95% upper confidence limit (UCL) current and future PCOC concentrations in groundwater, surface water, and sediment
- Background concentrations for naturally-occurring inorganic PCOCs in the PIA
- Groundwater flow directions and pathways in unconsolidated material and bedrock
- Surface water flow rates
- Information to support groundwater and surface water/sediment flow and fate and transport modeling (to allow prediction of future PCOC concentrations)

Decision 5 is required if the results of the risk-based decisions indicate groundwater, surface water, or sediment have been contaminated. Decision 5 involves a detailed assessment of remedial alternatives relative to a specific set of selection criteria. The types of information needed to support resolution of Decision 5 include:

- The nature and extent of contaminated groundwater, surface water, and sediment
- Preliminary ARARs and risk-based cleanup levels
- Background concentrations for naturally-occurring inorganic PCOCs in the PIA
- Physical properties of natural materials
- Information to support groundwater and surface water/sediment flow and fate and transport modeling
- Groundwater flow directions and pathways
- Surface water flow rates

The remainder of this section discusses each of the decision inputs identified above.

Potential Exposure Pathways and Receptors

Potential current and future exposure pathways and receptors (including an assessment of current and future land use) have been defined in consultation with the STI. This was discussed previously in Section A7.2.1.

Preliminary ARARs

Preliminary ARARs for groundwater and surface water are provided on Tables A7.2-4 and A.7.2-5, respectively. Hardness dependent ARARs will be calculated based on actual sample hardness values.

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PCOC Concentration Data

Substantial amounts of historic analytical chemistry data exist to estimate PCOC concentrations for groundwater, surface water, and sediment in the PIA AOIs south of the MA (i.e., the Western, Central, and Eastern Drainages). Little or no information exists for the other PIA AOIs. Previous studies have resulted in analytical chemistry data for the PIA collected by DMC, the USGS, EPA (START Program), and SMI (as contractor to DMC), and the Upper Columbia United Tribes Fishery Center (UCUTFC).

Based on the primary RI/FS objectives identified in Section A.7.2.2, the primary end uses of the PCOC concentration data are support of baseline human health and ecological risk assessments, and feasibility studies. Therefore, analytical chemistry data used to estimate PCOC concentrations for this RI/FS must meet the data quality requirements for conducting baseline risk assessments set forth in Guidance for Data Usability in Risk Assessment (EPA 1992a).

The historic analytical chemistry data for the PIA vary widely in their usability for risk assessment for the RI/FS. EPA's preliminary QA assessment of the analytical data reported in the USGS 1996 publication "Inventory Characterization and Water Quality of Springs, Seeps and Streams near Midnite Mine" resulted in a conclusion that the quality of data cannot be determined due to the lack of information (EPA 1996). In the case of older studies conducted by DMC and UCUTFC (i.e., studies conducted before 1998), it appears that the data were not collected using protocols required by EPA (1992a). Typical problems include unavailable or inadequate documentation of well construction or sampling procedures, unacceptable field data collection procedures or documentation, and failure to meet laboratory QA/QC and/or documentation requirements. Therefore, these data are not expected to be usable for baseline risk assessment purposes. Although these data cannot be used quantitatively in the risk assessments, they are useful for development of sampling design, selection of analytical methods, initial identification of potential chemicals of concern, and development of the conceptual site model (EPA 1992a).

In the case of more recent investigations conducted by the EPA and SMI (i.e., data collected since 1998), the investigations appear to have used protocols required by EPA (1992a), and, after review of the quality of the data, the data from those studies may be useable quantitatively for baseline risk assessment purposes when combined with data collected during the RI. Historic data quality will be reviewed in detail in accordance with EPA guidance (EPA 1992a) prior to use in risk assessment.

However, these data are not sufficient for conducting the baseline risk assessments for a variety of reasons. First, in all cases, the constituents analyzed in previous studies comprise only a subset of the PCOCs that must be evaluated for the baseline risk assessments. For example, a number of metals and radionuclide isotopes needed for the risk assessments were not analyzed for in the previous studies. Examples include cobalt, vanadium, and antimony, as well as decay series isotopes for radionuclides. Therefore, it is necessary to collect additional PCOC concentration data for the missing PCOCs.

Also, previous sampling locations were not sufficient to demonstrate that maximum PCOC concentrations have been measured. For example, previous groundwater sampling locations are

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not adequate to evaluate several potential pathways for migration of PCOCs from the MA to the PIA. Therefore, additional data collection is required for the RI/FS.

Background PCOC Concentrations

To date, insufficient background characterization has been conducted for the Midnite Mine site. Estimation of background concentrations for naturally-occurring inorganic constituents is necessary to evaluate whether PIA PCOC concentrations have been affected by historic mining activities, and to determine cleanup levels for media found to be contaminated. Additional data collection for the purpose of background characterization is necessary. The approach for background characterization and use of the data are discussed in Section A.7.3.

Physical Properties of Natural Materials and Information to Support Flow and Fate and Transport Modeling

Information concerning the physical properties of natural materials and to support flow and fate and transport modeling is necessary to support remedial alternatives evaluation in the FS. Predictive fate and transport modeling may also be necessary for the baseline risk assessment for certain PIA AOIs. While some information exists to support these objectives, additional data collection is necessary. For example, it is anticipated that information on the hydraulic properties of the alluvium and bedrock in the PIA will be necessary to perform flow and fate and transport modeling.

Although additional data collection is likely to be necessary to estimate physical properties and support predictive modeling, such data collection will be deferred until Phase 2 or later phases of the RI/FS for the following reasons:

- Information needs regarding the properties of physical materials and to support flow and fate and transport modeling for the FS are likely to be very alternative-specific. Therefore, it is appropriate to defer such data collection until specific remedial alternatives are identified in detail.
- Flow and fate and transport modeling for the purposes of supporting the baseline risk assessments is most likely to be necessary for the PIA AOIs for which current information is insufficient to determine whether PIA groundwater, surface water, or sediment have been affected or contaminated currently. If it is determined during Phase 1A that effects or contamination are present, then modeling may not be necessary. Alternatively, if it is determined that media have not yet been affected but may in the future, then predictive modeling may be required. Therefore, decisions regarding the need for additional data collection to support modeling should be deferred pending the results of the Phase 1A investigations.

Groundwater Flow Directions and Pathways

Groundwater hydraulic head data in the PIA are primarily limited to the axes of the drainages south of the MA (i.e., the Western, Central, and Eastern Drainages). Little or no hydraulic head information exists for the other PIA AOIs. Also, limited hydraulic head data are available for the bedrock. Additional hydraulic head data are necessary to confirm conceptual flow model

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assumptions of convergent horizontal flow toward the drainage axes. Additional hydraulic head data are necessary to evaluate vertical hydraulic gradients within the bedrock and between the alluvium and bedrock.

Surface Water Flow Rates

Surface water flow rate data are required along the reaches of the streams to estimate contaminant loading for the purposes of ecological risk assessment. Additional stream flow measurements will be necessary for various locations along the streams.

Tables A.7.2-2 and A.7.2-3 identify the inputs to the decisions for each of the PIA AOIs and for the Background Areas characterization.

A.7.2.4 DQO Step 4: Define the Study Boundaries

The purpose of Step 4 is to “*define the spatial and temporal boundaries that are covered by the decision statement.*” (EPA, September 1994a).

For the PIA as a whole, the spatial boundaries of the decision consist laterally of the entire PIA (i.e., that area beyond the MA boundary with the potential to be affected by the MA). The limits of this area, which extend laterally and vertically to encompass all mine-related contamination, will be defined during the course of the RI as a result of defining the nature and extent of contamination.

For each of the PIA AOIs, the lateral boundaries consist of the entire AOI, extending vertically as deep as the deepest affected groundwater flowpath (see Table A.7.2-2).

Temporal boundaries vary depending on the decision to be made. For Decision 1 in Section A.7.2.2 (i.e., Are exposure pathways associated with ground water, surface water, or sediment, in the PIA potentially complete and significant for humans or the environment, or are there ARARs associated with the media?), the temporal boundary consists of both current and future conditions. This is because the risk-based decisions must consider both current and future risks to humans and the environment.

Decisions 2 and 3 in Section A.7.2.2 (i.e., Have mining activities affected groundwater, surface water, or sediment in the PIA at levels above background concentrations? and, Have historic mining activities contaminated groundwater, surface water, or sediment in the PIA at levels that pose an unacceptable risk or fail to comply with ARARs, thereby requiring a remedy or remedies?) are focused on determining whether a release of contaminants has already occurred to the PIA. Therefore, these decisions address current conditions only. However, current conditions must be representative of maximum PCOC concentrations, therefore, seasonal data are required.

A preliminary evaluation of existing water quality data appears to indicate that PCOC concentrations vary with season, particularly for surface water and seeps/springs. Certain PCOCs appear to have higher concentrations in the high flow period (spring), while others may have higher concentrations in the low flow period (fall). Also it appears that some PCOC concentrations are highest early in the spring and others later in the spring. Therefore, it is

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proposed that water samples be collected at two times during the spring (e.g., early April and early May) to capture peak PCOC concentrations associated with the first runoff pulse and later runoff conditions. An additional sample is proposed for the low flow season (e.g., early October) to measure peak PCOC concentrations that occur in the dry season. Therefore, a total of three sampling events are proposed for groundwater and surface water.

In some drainages (i.e., Eastern Drainage and Blue Creek), PCOC concentrations in surface water may be affected by discharge from the Midnite Mine WTP. To monitor the effects of the discharge on surface water, at least one round of samples should be collected during both WTP discharge and non-discharge periods. The low-flow event and the second spring event are expected to occur during a WTP discharge period. The first spring event is expected to occur during a non-discharge period.

Decision 4 in Section A.7.2.2 (i.e., Will groundwater, surface water, or sediment in the PIA be contaminated in the future, thereby requiring a remedy or remedies?) is focused on future conditions. The risk assessment requires evaluation of risks for a period of up to 1,000 years in the future for radionuclides. Risk assessment guidance for evaluating radionuclides (EPA 1989, 1998) recommends evaluating different time scales to account for radioactive decay and ingrowth of decay products. The RESRAD program evaluates risk for up to 1,000 years because some daughter products become dominant contributors to risk over periods of hundreds or even thousands of years. For example, the maximum total dose in mrem/year for a hunting scenario at the Midnite Mine site was predicted by RESRAD to occur at 1,000 years (SMI 1999).

Decision 5 in Section A.7.2.2 (i.e., What is/are the preferred remedy/remedies for groundwater, surface water, or sediment in the PIA?) is also focused on future conditions, requiring evaluation of conditions for up to 1,000 years from the present.

Spatial and temporal boundaries for each of the PIA AOI are presented on Table A.7.2-2. Spatial and temporal boundaries for the Background Areas characterization are presented on Table A.7.2-3.

A.7.2.5 DQO Step 5: Develop a Decision Rule

The purpose of Step 5 is to “*define the parameter of interest, specify the action level, and integrate previous DQO outputs into a single decision statement that describes the logical basis for choosing among alternative actions.*” (EPA, September 1994a).

Figures A.7.2-6 and A.7.2-7 present the RI DFCs, which represent the RI decision rules, for PIA groundwater and surface water/sediment, respectively.

In both DFCs, the decision rule first involves assessing whether the exposure pathways associated with PIA groundwater, surface water, or sediment are potentially complete and significant for humans or the environment, or whether ARARs apply to the media (Boxes 1 and 2). This decision correlates with Decision 1 in Section A.7.2.2. If neither condition exists, then further analysis of these pathways would be unnecessary. Based on the human health and ecological CSMs presented in Section A.7.2.1, exposure pathways for PIA groundwater, surface

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water, and sediment are complete and significant for humans and the environment. Furthermore, ARARs exist for groundwater and surface water.

The next portion of the DFCs (Boxes 3 through 7) involve assessment of whether PIA groundwater, surface water, or sediment have been affected by historic mining activities. This portion of the DFC correlates with Decision 2 in Section A.7.2.2. The term “affected” in this case means that PCOCs related to mining activities are present in PIA groundwater, surface water, or sediment at concentrations exceeding their naturally-occurring pre-mining (i.e., “background”) concentrations (for organic PCOCs, it is assumed that the constituents were not present at detectable concentrations under pre-mining conditions). Resolution of this decision requires comparison of the maximum PCOC constituent concentrations present in the PIA AOI with estimated background PCOC concentrations. If PCOCs are not detected at concentrations exceeding their respective background levels, then it is concluded the MA has not affected groundwater, surface water, or sediment in the PIA AOI. Alternatively, if PCOCs are detected at concentrations exceeding background levels, it is concluded that the MA has affected groundwater, surface water, or sediment in the PIA AOI and assessment of risk and compliance with ARARs is necessary.

The next portion of the DFCs (Boxes 8, 9, and 15) involves assessment of whether the MA has contaminated groundwater, surface water, or sediment, thus, requiring assessment of remedial alternatives. This portion of the DFCs correlates with Decision 3 in Section A.7.2.2. The term “contaminated” means that mine-related PCOC concentrations in PIA groundwater, surface water, or sediment pose an unacceptable risk to humans or the environment, or fail to comply with ARARs for one or more of those media.

The distinction between this decision (Boxes 8, 9, and 15) and the previous decision (Boxes 3 through 7) is in the terms “affected” versus “contaminated”. Note that PCOCs must be mine-related to result in contamination. Because natural background concentrations of certain PCOCs at this site are expected to pose an unacceptable risk or fail to comply with ARARs, it is first necessary to determine that the PCOCs are present at the observed concentrations as a result of historic mining activities. That is the reason for the previous DFC decision (i.e., Boxes 3 through 7), to establish mine effects before conducting risk assessment or comparison to ARARs.

Resolution of the decision addressed in Boxes 8, 9, and 15 requires assessment of the human health and ecological risks posed by the PCOC concentrations, and evaluation of compliance with ARARs. Human health and ecological risk are estimated by conducting a baseline risk assessment. Compliance with ARARs is evaluated by comparison of maximum PCOC concentrations in the AIOs to ARARs. If it is determined that mine-related PCOCs in PIA groundwater, surface water, or sediment pose an unacceptable risk, or fail to comply with ARARs, it is concluded that PIA groundwater, surface water, and/or sediment in the AOI have been contaminated, thus requiring the feasibility study to address those media.

Alternatively, if PCOCs presently in the PIA AOI are determined not to pose an unacceptable risk and comply with ARARs, then it is concluded the MA has not currently contaminated PIA groundwater, surface water, or sediment in the PIA AOI. However, the possibility remains that

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the MA may contaminate those media in the future. This is possible for a variety of reasons. For example, there is the potential for deep groundwater flow paths that may originate within, and be contaminated by the MA, but may take extended time periods (e.g., many years) to reach the PIA. Another possibility is that leaching from buried ore/procore stockpiles in the MA near the MA boundary may worsen as a result of progressive oxidation within the piles, resulting in worsening groundwater quality migrating to the PIA in the future.

Therefore, the DFC also includes a decision (Boxes 10 through 14) involving prediction of whether PIA groundwater, surface water, or sediment will be contaminated in the future. This decision correlates with Decision 4 in Section A.7.2.2. Resolution of this decision involves the same considerations as the previous decision except that it is based on predicted future maximum PCOC concentrations in the AOI, rather than measured current concentrations. If it is determined that future PCOC concentrations will likely result in unacceptable risks or failure to comply with ARARs, then it is concluded that PIA groundwater, surface water, and/or sediment in the AOI may be contaminated, thus requiring a feasibility study to address those media. Alternatively, if it is determined that future concentrations of PCOCs are not likely to pose an unacceptable risk or fail to comply with ARARs, then it is concluded that the MA has not and will not contaminate PIA groundwater, surface water, or sediment in the AOI. Therefore, the feasibility study does not need to address those media.

A.7.2.6 DQO Step 6: Specify Limits on Decision Errors

The purpose of Step 6 is to “*specify the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data*” (EPA, September 1994).

Decision Statement 1 described in Section A.7.2.2 is concerned with qualitatively identifying exposure pathways and human and ecological receptors associated with groundwater, surface water, and sediment in the PIA. In addition, those media with ARARs are identified.

Professional judgement is used to determine if exposure pathways are potentially complete and significant. ARARs are obtained from appropriate regulations (Section A.7.2.3). Inputs to the Decision Statement 1 do not involve statistical inference and therefore, quantitative limits on tolerable decision errors are not appropriate.

Decision Statements 2 and 3 described in Section A.7.2.2 are concerned with concentrations of chemicals/radionuclides in a given medium relative to applicable action levels (Section A.7.2.3; EPA, 1989a, b). The applicable action levels for the Phase 1A RI/FS decision rules for surface water, sediment and groundwater are background concentrations for naturally-occurring inorganic chemicals/radionuclides, ARARs, and calculated risks. A mine-related effect is deemed to have occurred if a representative PIA concentration exceeds the estimated background concentration. Mine-related contamination is deemed to have occurred if concentrations of PCOCs in the PIA pose an unacceptable risk to human health or the environment, as determined in the baseline risk assessment, or exceed ARARs. Decisions involving representative PIA concentrations relative to background concentrations involve statistical comparisons and therefore, quantitative limits on tolerable decision errors are applicable. For the risk assessment

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and comparison to ARARs, the sampling effort was designed to capture the high-end or maximum surface water, sediment, and groundwater concentrations. Groundwater sampling well locations were deliberately placed at locations suspected to have the highest PCOC concentrations to assure that risk would not be underestimated for groundwater. Surface water and sediment sampling locations were placed both at locations most likely to have the highest PCOC concentrations from mine-related activities and from locations that reflect the full range of potential effects. Further, the collection of surface water samples will be scheduled so that the effects of discharge from the WTP on chemical concentrations can be evaluated. The maximum concentrations in each medium will be used to assess risk and compare to ARARs. Because no statistical comparison will be performed for comparison of PIA surface water, sediment, and groundwater concentrations to ARARs and risk levels, quantitative tolerable decision error limits are not appropriate.

Decision Statement 4 described in Section A.7.2.2 is concerned with concentration of chemicals/radionuclides in a given medium in the PIA in the future relative to applicable decision criteria. The applicable decision criteria for the Phase 1A RI/FS decision rules for surface water, sediment and groundwater are the same as those described above for Decision Statements 2 and 3. However, to predict future representative concentrations for surface water, sediment and groundwater, information to support surface water/sediment and groundwater flow and fate and transport modeling is needed. Professional judgement is used to select data collection points to estimate groundwater flow directions and pathways in unconsolidated material and bedrock.

Decision Statement 5 described in Section A.7.2.2 is concerned with a detailed assessment of remedial alternatives for surface water, sediment, and groundwater relative to a specific set of selection criteria. The selection criteria are qualitative in nature and do not involve statistical inference or quantitative limits on tolerable decision errors.

Decisions involving representative PIA concentrations in comparison to background involve statistical comparisons, whereas comparisons to ARARs and calculation of risks are based on sampling of maximum medium concentrations. There are two possible decision errors that can be made for each comparison.

Decision errors for the background comparison are: (1) deciding that the representative PIA concentration exceeds background when the true PIA concentration is less than or equal to background or (2) deciding that the representative PIA concentration does not exceed background when the true PIA concentration does exceed background (Table A.7.2-6). The consequence of the first decision error is unnecessary evaluation of risk posed by PCOCs in the PIA when, in reality, the concentrations are not mine-related. This may also result in unnecessary remediation of environmental media. The consequence of the second decision error is that potential hazards or risks to human health or the environment from mine-related activities are overlooked.

Decision errors involving risk and ARARs are: (1) deciding that the representative PIA concentration exceeds an ARAR or possess an unacceptable risk when the true PIA concentration does not or (2) deciding that the representative PIA concentration does not exceed

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the ARAR or does not pose an unacceptable risk when the true site concentration does. The consequence of the first decision error is declaring a risk to human health or the environment exists (or other effects on a resource exists) when no unacceptable risk (or other effect on a resource) actually exists. Subsequently, remediation may be required when remediation is not necessary. The consequence of the second decision error is potential hazards or risks to human health or the environment (or other effects on resources) are overlooked.

A.7.2.6.1 Quantitative Decision Errors

To set quantitative limits on the decision errors for the background comparisons, a set of hypotheses has been written in terms of the objective and parameters of interest (background and representative PIA concentrations). For the background comparison, the statistical test used will be a prediction limit method. This test is equivalent to testing if a given concentration in the PIA is equivalent to or lower than the background concentrations for a given medium:

Null hypothesis (H_0): $S \leq B(_)$

Alternative hypothesis (H_A): $S > B(_)$

Where: S is a given PIA concentration and $B(_)$ is a distribution of background concentrations.

The prediction interval method is used to test the background H_0 hypothesis. If the distributions of background and site PIA data are really the same, the PIA samples for a given medium should be contained below the upper prediction interval limit (EPA, 1992b). The prediction interval methodology is described in Section A.7.3.3.

Using the general hypothesis structure the decision errors for the background comparison can be expressed in terms of statistical terminology and the probability of making each error can be defined. The statistical hypotheses and the associated decision errors for the background comparisons are summarized in Table A.7.2-6. A Type I error or false positive decision is made when the H_0 is rejected, but the true PIA condition is that the H_0 is true. In other words, when the action level is a background prediction limit, this corresponds to declaring a mine-related effect has occurred when no effect has really occurred. The probability of making a Type I error is referred to as alpha (α).

A Type II error or false negative decision error is made when the H_0 is accepted, but the true PIA condition is that the H_A is true (i.e., H_0 is false). For example, for a background action level, a Type II error corresponds to declaring that no mine-related effect has occurred when in reality an effect has occurred. The probability of making a Type II error is referred to as beta (β).

When applying the upper prediction limit test, a site-wide false positive rate is specified, as opposed to setting an individual comparison false positive rate. The false positive rate (Type I error) is the rate at which the statistical analysis indicates that individual results are not part of the background population when, in reality they are.

The power of a test is the probability of detecting that the action limit is exceeded when it truly is exceeded. When the action level is a background limit, the power of the test is the probability of declaring that a mine-related affect has occurred when it has. Power is equal to one minus the

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Type II error rate (ϑ). We assumed that the tolerable decision error limit for the Type II error, and subsequently the power of the prediction limit test is equivalent to that provided in standard reference power curves provided by EPA (1992). A site-wide false positive error rate of 5 percent and a power level of at least 80 percent (Type II error rate equals 20 percent) for relative differences of 3.5 standard deviations is set in order to achieve a reasonable balance between the site-wide positive (Type I) and the false negative error rates. The number of background samples estimated to be required to meet these limits on tolerable decision error rates is described in Section A.7.3.4.

A.7.2.7 DQO Step 7: Optimize the Design

The purpose of Step 7 is to “*identify a resource-effective data collection design for generating data that are expected to satisfy the DQOs.*” (EPA, September 1994a).

This step of the DQO process is addressed in Section B1, Sampling Process Design (Experimental Design). A summary of the proposed data collection activities for each PIA AOI is provided on Table A.7.2-2 and Figure A.7.2-9 and A.7.2-10. A summary of the proposed data collection activities for the Background Area characterization is provided on Table A.7.2-3 and Figure A.7.2-11.

A.7.3 Background Characterization

Characterization of the concentrations of naturally-occurring inorganic constituents is needed to evaluate whether groundwater, stream surface water or stream-deposited sediment in the PIA have been affected or contaminated by materials and activities in the MA. For all media, “background” is the range of chemical/radiological concentrations that are naturally occurring in the site vicinity, in areas unaffected by the previous mining operations. Ideally, such an evaluation would be based on a comparison of existing environmental conditions at, and in the vicinity of, the mine to pre-mining conditions in the same area. However, available data related to pre-mining conditions are insufficient, making it necessary to select and characterize other background areas to represent pre-mining conditions in the comparison.

A.7.3.1 Characterization Approach

The approach that will be used to characterize background chemical constituent concentrations is to measure natural constituent concentrations at locations that: (1) are near the MA and the PIA; (2) have similar hydrogeologic characteristics to the Midnite Mine; (3) have not been affected by mining; and (4) are accessible for drilling or other sampling activities. The key assumption in this approach is that concentrations measured in groundwater, surface water, and sediment at the selected background locations are representative of the natural range of concentrations that were present at the Midnite Mine site prior to mining.

To define the range of background concentrations, samples will be collected from natural areas near the site that reflect the expected range of conditions that existed in the Midnite Mine MA and PIA. The MA and PIA include both mineralized and non-mineralized rock types, which was

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also true prior to mining. Since groundwater and surface water in the PIA would have flowed across or within a variety of geologic units even under pre-mining conditions, samples for background characterization will be collected in locations within and downgradient of mineralized and non-mineralized areas. Stream sediments in background areas are derived from both mineralized and non-mineralized source areas and sample locations have been identified to represent both area types.

Background sampling locations, including monitoring wells and surface water/stream sediment sampling locations, were selected with the intention of collecting samples that represent the range of naturally occurring concentrations in the respective environmental media. In the sample location selection process, data sources were reviewed to assess the distribution of rock types, chemical concentrations, and the locations of mineralized zones undisturbed by mining. These data sources are discussed below:

1. National Uranium Resource Evaluation - An Exploration Systems Approach to the Spokane Mountain Area Uranium Deposits, Northeastern Washington (Bendix 1981). The report shows the study area of the Spokane Mountain uranium deposit. Certain background monitoring wells, and surface water/sediment locations were selected based on the location of the deposit, and the mapped drainage pattern in the vicinity.

The report presents analytical results for surface water and stream sediment samples collected in the vicinity of the Midnite Mine, including Spokane Mountain and the Sand Creek drainage. The analytical results identify locations where the concentration of naturally occurring uranium appears to be elevated. Background samples for surface water/sediment are proposed to be collected at some of the previous locations where high concentrations were observed.

The report also includes a geologic map showing the distribution of geologic units and rock types, and locations of exploration drill holes in the Spokane Mountain mineralized zone. The geologic map was used to identify the distribution of rock types. Background well locations were selected so that the distribution of rock types that occur at Midnite Mine will be represented in the background locations.
2. Exploration drill hole data provided by Associated Environmental Scientists and Engineers (AESE 1999). An ArcInfo coverage of the exploration drill holes, including uranium content for different sampling intervals, was provided to URSGWC. These data were used to identify the lateral extent and depth of mineralized zones on Spokane Mountain, which were in turn used to identify target zones in background monitoring wells.
3. Geological Survey Bulletin 1131 Geology and Mineral Deposits of the Turtle Lake Quadrangle, Washington (USGS 1963). This geology report includes a description of the Deer Mountain uranium prospect and presents the location of the prospect on a geologic map. Background surface water/sediment samples are proposed downstream of the prospect.

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4. Inventory, Characterization, and Water Quality of Springs, Seeps, and Streams near Midnite Mine, Stevens County, Washington (USGS 1996). This report presents characterization of water quality in basins near the Midnite Mine that have not been influenced by the mine. The analytical results were considered in selection of proposed background surface water locations.

A.7.3.2 Data Analysis Approach

The data analysis approach and the number of samples to be collected both within background and the site depends on the intended uses of the data. A baseline risk assessment will be performed as part of the RI/FS process to evaluate if remedial action is required. A baseline risk assessment evaluates risk or hazards posed to humans and the environment from contamination of media due to existing and future conditions at a site. The baseline risk assessment performed for Midnite Mine will evaluate only those chemicals identified as exceeding background concentrations in a given medium. Background concentrations will also be required for determining cleanup levels for constituents that naturally occur at concentrations above ARARs and risk-based cleanup levels.

A brief outline of the data analysis approach that will be used for characterizing background and comparing to PIA data is provided below. The statistical methods used for characterizing background and comparing PIA data to background are provided in the next section.

A.7.3.2.1 Groundwater

One of the scenarios to be evaluated in the baseline risk assessment is a future resident that lives in the PIA and uses the groundwater as a domestic water source. The statistical approach will evaluate whether an individual sample result (i.e., individual well) exceeds background (i.e., null hypothesis: concentration of a chemical in well is less than or equal to background). In such a statistical approach, a groundwater background value is calculated using all background groundwater data. The concentration measured in a given well is then compared to the background concentration. If the concentration of the chemical in the well exceeds background it is retained as a PCOC to be evaluated in the risk assessment. If the concentration of the chemical in the well is at or below the background concentration, the chemical is not considered a PCOC for that well.

Constituent concentrations in groundwater may vary significantly with season. Therefore, groundwater data at each background well will be collected three times during a year (twice in the spring and once in the fall). In addition sampling at each PIA sampling location is proposed to occur three times during the year to capture potential seasonal variability. After data are collected, the presence of seasonal effects will be evaluated by comparing the three background data sets. If groundwater quality is significantly different between sets, a background value for each set will need to be calculated. If groundwater quality is not statistically different between sets, groundwater data for the three sets can be combined to calculate a single background value.

It is also possible that naturally occurring constituents will occur at different concentrations in different geologic units. To address this issue, groundwater wells will be installed both within

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the bedrock and alluvium for sampling. It is assumed that no significant variability between bedrock and alluvial groundwater quality in background areas occurs and all of the background groundwater data will be used to characterize the background population. After data are collected, this assumption will be tested by comparing the two data sets to evaluate whether additional wells may be needed. If background groundwater quality is statistically different between unconsolidated and bedrock material, additional wells in each stratum would be placed and sampled. A background range of values for unconsolidated material and one for bedrock would then be statistically determined. If unconsolidated material and bedrock water quality is not statistically different, the data from both geologic units can be combined.

After the background is characterized (i.e., strata and seasonal effects are accounted for), individual data in the PIA will be compared to the appropriate background value. If background data can be combined across a season or seasons, multiple samples at the same PIA well location can be used as "verification" samples. Figure A.7.3-1 presents the decision logic for PIA groundwater concentration comparisons to background.

A.7.3.2.2 Surface Water and Sediment

Surface water and sediment exposure scenarios to be evaluated in the baseline risk assessment include traditional/subsistence use and aquatic life uses. The baseline risk assessment will evaluate only those chemicals in a given medium identified as exceeding background concentrations. For each medium (surface water and sediment) and the constituents to be evaluated, a background range of values will be determined using a prediction limit approach and an upper prediction limit calculated. Surface water or sediment concentrations will be compared to this statistically derived background upper prediction limit. Comparisons to the background upper prediction limit will be conducted for constituents in each medium at each sampling location. Constituents within a given medium that are not significantly higher than background for all sampling locations will not be considered in the human health risk assessment. Constituents for which one or more individual values exceed the background prediction limit will be considered in the human health risk assessment. At a given sampling location, only those constituents exceeding the background upper prediction limit will be considered in the ecological risk evaluation for that location.

Surface Water

Constituent concentrations in surface water may vary significantly with season and WTP discharge. Therefore, surface water data at each background location will be collected three times during a year at the same time as PIA samples (Section A.7.2.4). After data are collected, the presence of seasonal and flow condition effects will be evaluated by comparing the three data sets. If surface water quality is significantly different between data sets, a background upper prediction limit for each set will be calculated. If surface water quality is not statistically different between data sets, surface water data for the three sets will be combined to calculate a single background upper prediction limit.

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After background is characterized (i.e., seasonal effects and flow condition are accounted for), individual data in the downgradient surface water can be compared to the appropriate background upper prediction limit. If background data can be combined across data sets, multiple samples at the same downgradient surface water location can be used as "verification" samples. Figure A7.3-2 presents the decision logic for PIA surface water concentration comparisons to background.

Sediment

Historically sediment data have been collected both on a point-sampling basis and on a composite basis. The measure of variability among composites is not equivalent to the measure of variability among individual samples. Since individual variability of the grab samples within the historic composite samples was not measured, no comparison between point and composite results can be made. For historic data to be used in the risk assessment, and to be statistically compared to background, requires that samples be collected in the same manner as historic data. Therefore, background upper prediction limits based on both point sampling and composite sampling are required for sediment. Sediment data will be collected up to two times. After the first round of downgradient samples and background data are collected, downgradient point sediment sample concentrations will be compared to the point sample background concentrations and downgradient composite sediment sample concentrations will be compared to the composite sample background concentrations. Figure A.7.3-3 presents the decision logic for PIA sediment concentration comparisons to background. An additional round of downgradient samples may be collected at some locations to verify the results of the background comparison.

A.7.3.3 Statistical Methods

A brief outline of the statistical methods that may be used in the background comparison is provided below.

Comparison between Alluvium and Bedrock Background Populations

EPA-recommended methods (EPA, 1998a) for comparison of two populations will be used to evaluate strata effects. The recommended parametric test is the Students t-test (assumes data are normal or lognormal) and the nonparametric approach is the Wilcoxon Rank Sum test. A nonparametric method is valid even when the background data do not follow a specific probability distribution (such as normal or lognormal). The data will be tested for normality or lognormality. If the data are normally or lognormally distributed the parametric Student's t-test will be used to test for strata effects; otherwise the nonparametric test will be used.

Comparison between Seasons (i.e., Comparison between Multiple Populations)

EPA-recommended methods (EPA, 1992b) for comparison of multiple populations will be used to evaluate seasonal effects. The parametric method is called one-way ANOVA and the nonparametric method is called the Kruskal-Wallis test. The data will be tested first for

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normality or log normality. If the data are normally or lognormally distributed, the parametric method will be used to test for seasonal effects; otherwise the nonparametric approach will be used.

Comparison of Individual PIA Samples to Background

The method used to compare individual PIA samples to background will be based on whether a parametric or nonparametric statistical method will be used. If a nonparametric comparison is conducted, a prediction limit approach will be used. If a parametric comparison is conducted, a combined tolerance and prediction interval method will be used (EPA, 1992b).

A tolerance interval establishes a concentration range that is constructed for each constituent to be evaluated to contain a specified proportion (P%) of the population with a specified confidence coefficient (EPA, 1989). The proportion of the population included, P, is referred to as the coverage. The probability with which the tolerance interval includes the proportion P% of the population is referred to as the tolerance coefficient. For example, 95% coverage means that random observations from the same distribution as the background would exceed the upper tolerance limit less than 5 percent of the time. A confidence coefficient of 95 percent means that one has a confidence level of 95 percent that the upper 95% tolerance limit will contain at least 95% of the distribution of observations from background.

A prediction interval is a statistical interval calculated to include one or more future observations from the same population with a specified confidence (EPA, 1992b). The upper prediction limit is a statistical estimate representing the maximum concentration that the next k sampling/analysis results will not exceed if they are from the same population (i.e., background), with a specified level of confidence. When applying the upper prediction limit test, a site-wide false positive rate is specified, as opposed to setting an individual comparison false positive rate. The false positive rate (type I error) is the rate at which the statistical analysis indicates that individual results are not part of the background population when, in reality they are. If there is no statistically significant seasonal variation, verification samples will be used to achieve a balance between false positive and false negative rates for the comparisons. If no verification samples can be collected (in case of significant seasonal variations), then additional statistical evaluation based on the background data will be considered to reduce the false positive rate.

A.7.3.4 Calculation of Number of Background Samples

The sample size requirements needed for background characterization were calculated assuming that the nonparametric prediction limit method would be used to establish a background limit against which all PIA data would be compared. This method is one of the EPA-recommended methods of statistical analysis to evaluate whether the differences between site and background data are statistically significant. Because it is a nonparametric method, it is valid even when the background data do not follow a specific probability distribution (such as normal or lognormal). Simulation results show that the nonparametric method is more powerful than a parametric method when the data are not normally distributed. Furthermore, the nonparametric method is

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nearly as powerful as a parametric method when the background data are in fact normally distributed.

Table A.7.3-1 shows the estimated minimum number of background samples in each distinct background area for different numbers of independent future comparisons. EPA (1992b) recommendations were used in determining the sample size requirements. Gibbons (1994) and EPA (1992b) suggest the use of verification samples in order to achieve a reasonable balance between false positive and false negative errors. Table A.7.3-1 includes a strategy of zero, one, and two verification samples. A resample strategy, in conjunction with the recommended sample size for the background data, is among the strongly recommended strategies by EPA (EPA, 1992b).

To control the Type I error and collect a realistic number of samples, the number of comparisons (i.e., combination of individual samples and constituents) needs to be relatively small. Based on our understanding of site conditions and data at similar sites, we expect that many of the constituents would be non-detects. Assuming reasonable detection limits, these constituents would not require a statistical comparison with background. We also expect that some of the constituents would be substantially above the background. For these constituents, the probability of making Type I error (i.e., incorrectly concluding that the chemical is of concern) would be very small. Thus, out of the chemicals of potential concern, we expect that the number of constituents requiring a statistical comparison with the background with a reasonable Type I error will be up to 10 per medium. Based on 10 constituents per medium to be compared to background and the number of site groundwater and site-related surface water sample locations, the power analysis indicates a minimum of 16 sample locations is needed to perform the non-parametric analysis of the data. Once the sample data are collected, these assumptions regarding the number of compounds requiring statistical comparisons will be verified and the sampling plan revised if necessary.

For surface water background characterization, 16 discrete background locations were identified for the Phase 1A field investigation. Each background location will be sampled three times during a year.

The existing data for sediment downstream of the MA are of two types: discrete samples (Ecology & Environment, 1998) and composite samples (Shepherd Miller, 1999). Thus, to conduct a statistically appropriate comparison, a minimum of 16 background sediment samples for each sample type (discrete and composite) is needed for comparison to the downstream samples. Therefore, 32 sediment samples (16 discrete and 16 composites) will be collected for background characterization from 16 sediment sample locations. If constituent concentrations exceed background in the first round of sampling, a verification sampling round for those parameters and locations will be required.

A total of 20 background well locations were selected because there is uncertainty regarding groundwater flow gradients along the northwest and northern boundaries of the mine due to the hydraulic influence of Pit 4. Although all of the proposed well locations are expected to be hydraulically upgradient of the MA, potentiometric surface data collected from the new wells may indicate that some of the proposed background wells are potentially downgradient of the

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MA. Therefore, four additional background well locations were selected to help ensure that sufficient background groundwater data are collected.

A.7.4 Specifying Measurement Performance Criteria

The overall QA objective for this project is to develop and implement procedures for obtaining and evaluating data that meet the DQOs to assure or confirm that the required decision can be made at the specified level of acceptable uncertainty. QA procedures are established to assure that field measurements, sampling methods, and analytical data provide information that is comparable and representative of actual field conditions, and that the data generated are technically defensible.

The QA objectives are defined in terms of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. The primary goal of this QAPP is to define procedures that assure the quality and integrity of the collected samples, the representativeness of the results, the precision and accuracy of the analyses, and the completeness of the data. Data that meets the QA objectives and goals will be deemed acceptable. Data that do not meet objectives and goals will be reviewed on a case-by-case basis to ascertain usefulness.

To achieve the required DQOs, the QAPP is designed to assure that a sufficient number of samples will be collected using technically valid scientific procedures. Utilization of the QAPP requires implementation of procedures for obtaining and evaluating data in a manner that will result in a quantitative or qualitative representation of the five PARCC parameters. The parameters of precision, accuracy, and completeness provide a quantitative measure of the statistical significance of the data collected in this field program. The parameters of representativeness and comparability utilize documentation of the site and laboratory procedures to qualitatively evaluate the data. Following the collection and analysis of the samples, a determination will be made whether the DQOs established for the QAPP were satisfied.

A.7.4.1 Analytical Data Quality Levels

There are two levels of analytical data quality defined by EPA (EPA, September 1993) that are relevant to the data collection activities during the Phase 1A field investigation. These levels are:

- Screening data: Generated by rapid, low precision methods of analysis, often times in the field, with minimal sample processing and preparation. Screening data provide presumptive evidence of the presence of target analytes and estimated quantification of these analytes. A percentage of the screening data points may be confirmed using definitive methods to support programmatic decisions made based on such results.
- Definitive data: Generated using rigorous analytical methods and QA/QC protocols in environmental analytical laboratories as well as the field. Definitive data provide reliable, well-documented identification, quantification, and confirmation of target analytes. These data require determination of either analytical or total measurement error, and compliance with program-required QC performance criteria.

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Data collection during the Phase 1A field investigation will include the generation of both screening and definitive data as summarized in Section B.4.

Some field-completed parameters will be used in the risk assessment and/or modeling and will therefore require higher data quality than the traditional definition of screening data from above. Currently, some field-completed screening data will require QA/QC data including instrument calibration, method performance checks, sensitivity verifications, method duplicates, and method blanks as applicable (Section B.4 and Table B.4.4-1).

Definitive data will include quality assurance data as defined by the specific method and may include a QC report comprised of laboratory control samples, method blanks, duplicates, matrix spikes/matrix spike duplicates, and anomalies, as applicable. Additional information will be available upon request. Further discussion of data report content is provided in Section A9.

A.7.4.2 Data Quality Indicators

Data quality indicators for screening and definitive data are defined in terms of the PARCC parameters in this section. The assessment of the data quality indicators is necessary to determine data usability and involves the evaluation of the PARCC parameters. Data quality indicators are summarized in the following subsections. Procedures for evaluating the PARCC parameters are provided in Section D3.

A.7.4.2.1 Precision and Accuracy

The precision and accuracy of a data set are generally a function of sample collection technique, the analytical method and sample matrix. Precision and accuracy objectives for definitive analyses are documented in laboratory SOPs which are based on standard EPA methods. The precision and accuracy achieved by the laboratory will be consistent with the requirements established by the laboratory method protocol, EPA method guidelines, and the requirements summarized in Section B4.

The procedures for evaluating precision and accuracy data are provided in Section D3. Samples will be reanalyzed or data will be qualified, as necessary, on the basis of the results of these evaluations. If accuracy and precision goals are not attained, the reasons will be investigated and corrective actions taken if needed.

A.7.4.2.2 Representativeness

Representativeness expresses the degree to which sample data precisely and accurately represents a characteristic of a population, parameter variations at a sampling location, a process condition, or an environmental condition. Representativeness is a qualitative parameter most concerned with the proper design of the sampling program, proper sampling locations, implementing proper sampling protocols, and collecting a sufficient number of investigative samples, such that the analytical data generated are representative of actual site conditions. Representativeness of data is critical to data usability assessments.

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Representativeness is addressed in the SAP (Appendix A) by describing sampling techniques and the rationale used to select sampling locations. Representativeness will also be qualitatively evaluated using precision and accuracy information developed from the evaluation of QC duplicate samples. The representativeness of the data will be maintained throughout the Phase 1A field investigation by designing a representative sampling program, following appropriate and consistent procedures for sample collection, and by the application of generally recognized and documented analytical methods. Following these procedures increases the probability that representative samples will be collected from the sampling areas each time a sample is collected.

A.7.4.2.3 Completeness

Data are considered valid if confirmed by the examination and prerequisites of objective evidence that designated requirements for a specified intended use were fulfilled. Determination of whether individual results are considered valid will be achieved following the procedures specified in Section D.1 “Data Review, Validation, and Verification Requirements.”

Following completion of the analytical testing and data validation, the overall percent analytical completeness will be calculated by the following equation:

$$\% \text{ Analytical Completeness} = \frac{\text{Number of valid results or acceptable measurements}}{\text{Total number of requested measurements}} \times 100$$

The number of valid results includes data qualified as estimated. The level of completeness can be increased by collecting additional samples.

A.7.4.2.4 Comparability

To evaluate the comparability of the data, sampling and analytical techniques must be considered. Comparability of the data generated during the Phase 1A field investigation will be maintained by strictly following sampling SOPs, using standard analytical methods, evaluating data, evaluating the external QC duplicate samples, reviewing laboratory reports, and reporting values in consistent units.

A.8 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

All personnel assigned to the project, including employees and consultants, will be qualified to perform the tasks to which they are assigned. Appraisal of personnel qualifications will be made by the URSG Project Manager. The appraisal will include the comparison of the job assignment requirements with the relevant experience and training of the prospective assignee. It will also include a determination if further training is required, and, if required, by what method. On-the-job training is an acceptable training method if such training is provided by a person qualified to perform the trainee's assignment and the results of such training are documented.

Hazardous waste site certifications are not required for personnel completing non-intrusive work unless there is a potential for chemical exposures approaching published limits. Mine Safety and

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Health Administration (MSHA) certification requirements do not apply to the Midnite Mine Site because it is not an active mine.

Occupational Safety and Health Administration (OSHA) regulations require that all personnel entering hazardous waste sites meet specific medical monitoring and training requirements. Personnel who have a potential for exposure to hazardous substances at the site must have a current physician's statement to document medical eligibility to complete assigned tasks. The URSG Medical Surveillance Program is described in detail in the URSG Health and Safety Program Manual.

40-hour initial and current 8-hour annual OSHA hazardous waste site worker training are also required for personnel who have a potential for exposure to hazardous substances at the site. Additionally, at least two employees at the site will have current first aid and cardiopulmonary resuscitation (CPR) training and the URSG Site Manager will have site supervisor training.

All site personnel will also participate in an initial site orientation meeting and daily "tailgate" safety meetings to discuss the effectiveness of health and safety procedures, control measures, and the need for their revision. Radiation worker training is not required due to low levels of radiation present at the site, however, all URSG employees and subcontractors must complete a radiation awareness course prior to work at the site.

U.S. Department of Transportation and International Air Transport Association regulations require that employees involved with transporting hazardous materials complete specific training requirements. Site personnel will be trained regarding hazardous materials transportation prior to shipment of any hazardous materials.

A.9 DOCUMENTATION AND RECORDS

A.9.1 Purpose/Background

The following paragraphs define critical project records and information that will be included in reports. Reporting formats and document control procedures that will be used on this project are also defined.

A.9.2 Information Included in Reporting Packages

The data reporting packages will include all data necessary to support human health and ecological risk assessments and potential litigation concerning remediation of the site. Field and laboratory records will be integrated, as much as possible, to provide a continuous reporting track.

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A.9.2.1 Field Operation Records

At a minimum, the following field operation records will be included in the reporting packages.

- Sample collection records which will contain the names of persons conducting the sampling activity, sample number and location, number and type of samples collected, equipment, any unusual observations, and references to bound field log books.
- Completed Chain of Custody Forms. Chain of custody forms will include QC sample documentation and results of preservation checks.
- Any corrective action reports.

A.9.2.2 Field Testing Records

At a minimum, the following field testing records will be included in the reporting packages.

- Sample data sheets which will contain analysis date and time, sample number and location, method and results.
- QC Summary containing sample duplicate, calibration and blank results, as applicable.
- A narrative detailing any deviations from the methods prescribed in the QAPP.

A.9.2.3 Laboratory Records

At a minimum, the following laboratory records will be included in the reporting packages.

- Sample data which will contain analysis date and time, sample number and location, method, method detection/quantitation limits, dilution factors, data file numbers and laboratory numbers.
- Sample Management Records which will contain documentation of sample receipt and storage.
- A case narrative detailing any deviations from the methods prescribed in this QAPP and any QC nonconformances, problems or comments.
- QA/QC Report which will include all instrument calibration and calibration verification data, blank data, spike data, and replicate data that supports this project and any other relevant QC data.
- Data Handling Records which will include copies of extraction bench sheets, instrument log book sheets, standard preparation logs, bench sheets, and calculation worksheets.
- Corrective Action Reports.
- The laboratory will also prepare an electronic deliverable containing results and QC information. The electronic deliverable will be submitted as part of the data reporting package.

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A.9.3 Data Reporting Package Format and Documentation Control

Laboratory data reporting packages will include standard CLP forms (OLC02.0, OLM03.0 and ILM04.0 or more recent versions) for VOCs, SVOCs, and metals (with the exception of arsenic), and all raw data supporting the information on the CLP forms (including bench sheets). Data reporting packages for VOCs, SVOCs, and metals (with the exception of arsenic) will conform to all CLP requirements (OLC02.0, OLM03.0 and ILM04.0 or more recent versions).

For non-CLP methods, the data reporting package will include CLP-like laboratory forms that summarize results and QC information and all raw data supporting the information on the summary forms (including bench sheets). Section A.9.2 provides minimum requirements of what information will be included in data reporting packages.

The hardcopy data reporting packages will be paginated (including raw data) beginning with the case narrative.

Handwritten information or corrections will be in indelible ink, dated and initialed. All CLP forms (or CLP-like laboratory equivalent forms) will be signed and dated by the analyst or laboratory supervisor. All handwritten corrections will be made by a single strike through line, the correction clearly written, dated and initialed. All corrections to the hardcopy package will also be carried through to the electronic files. Corrections may be made by the analyst, laboratory supervisor or Laboratory QA Manager, or URSG data reviewer or URSG Project QA Manager.

The URSG Project QA Manager may initiate a revision of the laboratory data reporting package. A revised laboratory data reporting package, along with a narrative explaining the reasons for the revisions, would then be prepared by the laboratory and transmitted to the URSG Project QA Manager. All revised data will be clearly labeled as additional data. Both revised and original data would be kept in the project data file.

A.9.4 Data Reporting Package Archiving and Retrieval

The laboratory will archive data reporting packages and instrument tapes and logs for 365 days after data submission. During the duration of the laboratory contract, data reporting packages, instrument tapes, and data logs will be submitted by the laboratory seven days after receipt of a written request from EPA or URSG defining information required.

URSG will archive data reporting packages and field records with the project files until completion of the Work Assignment. At that time, URSG will turn over to EPA all originals from the project file. URSG may retain a copy of the project file after Work Assignment Closeout. During the course of the Work Assignment, data will be submitted to EPA seven days after receipt of a written request from EPA defining information required.

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Table A.4-1

PROJECT DIRECTORY FOR THE MIDNITE MINE RI/FS

Name	Project Role	Street Address	City and State	Zip Code	Phone and Fax Numbers
Elly Hale	EPA Work Assignment Manager	1200 Sixth Ave.	Seattle, WA	98101	Phone: 206-553-1215 Fax: 206-553-0124
Bruce Woods	EPA Quality Assurance Manager	1200 Sixth Ave.	Seattle, WA	98101	Phone: 206-553-1193 Fax: 206-
Scott Myers	URSG Project Manager	2401 Fourth Ave., Suite 1000	Seattle, WA	98121	Phone: 206-674-1888 Fax: 206-674-1801
John Thackston	URSG Technical Advisor	Stanford Place 3, Suite 1000 4582 S. Ulster Street	Denver, CO	80237	Phone: 303-740-2708 Fax: 303-694-3946
Tim Joseph, CIH	URSG Project Health and Safety Manager	Stanford Place 3, Suite 1000 4582 S. Ulster Street	Denver, CO	80237	Phone: 303-740-2767 Fax: 303-694-3946
Alan Roberts	URSG Project Quality Assurance Manager	Stanford Place 3, Suite 1000 4582 S. Ulster Street	Denver, CO	80237	Phone: 303-740-2766 Fax: 303-694-3946
Larry Brook	URSG Project Chemist	Stanford Place 3, Suite 1000 4582 S. Ulster Street	Denver, CO	80237	Phone: 303-740-2787 Fax: 303-694-3946
Dave Nicholson	URSG Site Manager	Stanford Place 3, Suite 1000 4582 S. Ulster Street	Denver, CO	80237	Phone: 303-740-2762 Fax: 303-694-3946
Patricia Manrique	URSG Site Sample Manager	White Shield, Inc. 801 Grandridge Road	Grandview, WA	98930	Phone: 509-882-1144 Fax: 509-882-4566
Kris Hinds	URSG Site Health and Safety Manager	2401 Fourth Ave., Suite 1000	Seattle, WA	98121	Phone: 206-674-1858 Fax: 206-674-1801

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Table A7.2-1
PIA AREAS OF INTEREST

Western Drainage
Central Drainage
Eastern Drainage
Northeastern Drainage
Northern Drainage
Northwest Ridge
Far West Drainage
Southwestern Drainage
Blue Creek

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Western Drainage	Potentially Impacted Area (PIA)	The Western Drainage is the downstream extension of the topographic surface drainage that formerly existed within and drained the western portion of Mined Area (MA). The Western Drainage currently extends from the southern MA boundary, just south of the toe of the South Spoils, to the confluence with the Eastern Drainage approximately 2,700 feet to the southeast.	Determine whether exposure pathways associated with surface water, sediment, or groundwater are potentially complete and significant for humans or the environment, and/or whether ARARs apply (see PIA Surface Water/ Sediment and Groundwater Decision Flow charts.	Lateral: The portion of the PIA within the Western Drainage, extending southeastward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected bedrock flow path. Temporal: Current and future conditions	Human health and ecological conceptual site models (CSMs) Preliminary ARARs	None None	None None	The CSMs depict the complete and significant exposure pathways for humans and the environment. The CSMs indicate that exposure pathways associated with surface water, sediment, and groundwater are potentially complete and significant. Preliminary ARARs exist for PIA groundwater and surface water.
		Water is discharged to the Western Drainage from seeps/springs located where the drainage is truncated by the western portion of the South Spoils. Water emanating from the seeps/springs is believed to be derived from subsurface flow pathways in the western portion of the MA, including historic drainages now buried by waste rock or stockpile material, possible trans-drainage pathways associated with mine haul roads or other flow barriers, backfilled pits, and bedrock flow pathways. Flow pathways originating at the Vehicle Shop and Mine Offices Area may also lead to the Western Drainage seeps/springs. Spills of vehicle-related petroleum products are suspected to have occurred in the Vehicle Shop and Mine Offices Area, based on detailed evaluations of aerial photographs (Peters, 1999b).	Determine whether affected surface water, sediment, or groundwater has migrated past the MA boundary in the Western Drainage. (see PIA Surface Water/Sediment and Groundwater Decision Flow charts.	Lateral: The portion of the PIA within the Western Drainage, extending southeastward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum constituent concentrations for all PCOCs in: <ul style="list-style-type: none">Seep/spring water, sediment, and groundwater at MA boundary along primary flow axis.	Seep/spring water, WDSEEP, Up to 3 events Sediment , SDWD-01, Up to 2 events Water table GW, MW-1, Up to 3 events Deep Bedrock GW, MWWD-01, Up to 3 events	VOCs (GW only), SVOCs, metals, radionuclides, inorganics, TPH, other parameters	This decision requires the results of chemical analyses for vehicle-related organic constituents (which do not occur naturally in this environment), and a comparison of naturally-occurring inorganic PCOC constituent concentrations to background concentrations to determine whether the MA has affected these media. Maximum PCOC concentrations in surface water and groundwater are expected to occur along or near the drainage axis and may vary with season. Moreover, the maximum concentrations for all PCOCs may not occur during the same seasons (i.e., some maximum concentrations may occur in the spring and others in the fall). To evaluate maximum PCOC concentrations in the risk assessment, PCOC concentration data are necessary for the high flow (i.e., spring) and low flow (i.e., fall) seasons. To increase the likelihood of measuring the maximum PCOC concentrations in the high flow period, two sampling events are planned. Therefore a total of 3 events are planned for groundwater and surface water sampling (two in the spring and one in the fall). Less than three sampling events are necessary to resolve this decision if the data indicate that vehicle-related organic PCOCs are present or naturally-occurring inorganic PCOC concentrations exceed background levels. Maximum sediment concentrations are expected to occur during the low flow season, when the effects from evaporative deposition of salts may be at a maximum. Therefore, one sampling event for sediment is planned for the fall. Additional sediment samples will be collected as verification samples at locations where PCOC concentrations in samples from the fall event exceed background levels. Currently available information appears to indicate that seep/spring water, surface water, sediment, and alluvial and bedrock groundwater in the Western Drainage have been affected by the MA.
		A portion of the seep/spring water is contained by a collection and pump back system operated to control migration of water from the MA to the PIA. However, a portion of the seep/spring water escapes down the drainage, particularly during high flow conditions. The Western Drainage also receives surface water runoff from a ditch extending along the western and southwestern edge of the MA, and direct runoff from the central portion of the South Spoils.			<ul style="list-style-type: none">Surface water, sediment, and groundwater along length of Western Drainage	Surface water, SWWD-01, Up to 3 events Sediment, SDWD-02, Up to 2 events Water table GW, GW-35A, Up 3 events Deep Bedrock GW, GW -50, Up to 3 events	VOCs (GW only), SVOCs, metals, radionuclides, inorganics, TPH, other parameters	Changes in surface water and sediment constituent concentrations may occur with increasing distance from the MA as a result of groundwater discharge, including discharge from deep groundwater flow pathways. Therefore, surface water (SWWD-01) and sediment (SDWD-02) constituent concentration data are required further down the drainage for use in evaluating the potential for changes in quality as a result of groundwater discharge. Changes in groundwater quality at the water table may occur along the drainage as a result of upward flow of bedrock groundwater, or downward movement of surface water or sediment constituents. Groundwater constituent concentration data from a water table well (GW -35A) will be used to evaluate the potential for changes in groundwater quality at the water table along the drainage as a result of discharging bedrock groundwater or infiltration of surface water or sediment constituents. Progressively deeper bedrock groundwater flow paths may converge upward toward the drainage with increasing distance from the MA. Bedrock groundwater constituent concentration data (GW-50) will be used to evaluate the potential for contamination in deeper bedrock flow paths potentially discharging in the PIA.
		The Western Drainage may also receive water as a result of groundwater discharge along its course, either from flow paths in unconsolidated materials or from bedrock. Water table groundwater flow pathways from the western MA are expected to be convergent toward and along the Western Drainage alignment. Groundwater may flow upward to discharge to the drainage, or may receive surface water infiltration from the drainage. Deeper bedrock groundwater also possibly converges horizontally and vertically toward the drainage. Therefore, deep bedrock flow paths originating in the MA may discharge along the drainage.			<ul style="list-style-type: none">Surface water, sediment, and groundwater immediately upstream of confluence with Eastern Drainage	Surface water , WDAC, Up to 3 events Sediment, SDWD-03, Up to 2 events Water table GW, MWWD-04, Up to 3 events Deep Bedrock GW, MWWD-05, Up to 3 events	VOCs (GW only), SVOCs, metals, radionuclides, inorganics, TPH, other parameters	Constituent concentration data for surface water (WDAC) and sediment (SDWD-03) upgradient of the confluence with the Eastern Drainage will be used to evaluate the potential for changes in quality with distance from the MA as a result of groundwater discharge. Groundwater constituent concentration data from a water table well (MWWD-04) will be used to evaluate the potential for changes in groundwater quality at the water table along the drainage as a result of discharging bedrock groundwater or infiltration of surface water or sediment constituents. Bedrock groundwater constituent concentration data (MWWD-05) will be used to evaluate the potential for contamination in deeper bedrock flow paths potentially discharging in the PIA.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Western Drainage (cont.)		Groundwater flow may also exist along the alignment of the Western Drainage, without interaction with the surface water in the drainage.			2) Groundwater flow directions and pathways in unconsolidated material and bedrock.	Groundwater elevations, all existing wells in Western Drainage and two new piezometers, MWWD-02 and MWWD-03, 4 seasons Streambed elevations, WDSEEP, SWWD-01, and WDAC, 1 measurement	Groundwater elevations Streambed elevations	Water table and deeper bedrock groundwater flow is expected to be horizontally convergent toward the drainage axis, but gradients may vary with season. Vertical groundwater flow directions may be upward, downward, or neither and may also vary with season. Based on topography, it is speculated that deeper bedrock flow paths will be upward toward the drainages. Groundwater elevations and stream elevations will be used to estimate horizontal and vertical groundwater flow directions and surface water/groundwater interactions. The two new piezometers, MWWD-02 and MWWD-03, will provide information to assess the hypothesis of convergent horizontal bedrock flow toward the drainage.
					3) Background concentrations for PCOCs in surface water, sediment, and groundwater (alluvial and bedrock)	See background sampling program	See background sampling program	This decision involves comparison of potentially affected concentrations for naturally-occurring inorganic constituents to background concentrations. The background sampling program is described separately. For vehicle-related organic constituents (which do not occur naturally in this environment), the presence of the constituents in water or sediment will be sufficient to determine the presence of mine effects.
		The quality of water emanating from the seeps/springs at the toe of the South Spoils appears to have been affected by the MA. Water from seep/spring sampling location WD SEEP contains elevated gross alpha particle activity (activity of 2,829 pCi/L observed; MCL is 15 pCi/L) and radium activities in excess of MCL. Manganese and sulfate are elevated above SMCLs. Uranium concentrations also appear elevated (1,500 pCi/L observed for U ₂₃₄ and U ₂₃₈).	Determine whether contaminated surface water, sediment, or groundwater has migrated beyond the MA boundary in the Western Drainage, and conduct baseline risk assessments (see PIA Surface Water/Sediment and Groundwater Decision Flow charts.	Lateral: The portion of the PIA within the Western Drainage, extending southeastward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum or 95% UCL PCOC constituent concentrations in seep/spring water, surface water, sediment, and groundwater at or downgradient of the MA boundary (locations as above that indicate mine effects)	Same samples as above with the exception that 3 data collection events (up to 2 events for sediments) are required to support the baseline risk assessments	VOCs (GW only), SVOCs, metals, radionuclides, inorganics, TPH, other parameters	This decision involves the comparison of maximum or 95% UCL PCOC constituent concentrations to preliminary ARARs and assessment of whether the maximum concentrations pose an unacceptable risk. The constituent concentration information obtained in the previous decision is also used for this decision, but may be supplemented by data for additional seasons. Currently available information strongly indicates that seep/spring water, surface water, sediment, and alluvial and bedrock groundwater in the Western Drainage have been contaminated by the MA.
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur.
					3) Surface water flow rate	Temporary flume, all surface water sampling locations identified above, 4 seasons	Surface water flow rate	Estimation of mass loading of contaminants via streams is necessary for the ecological risk assessment. Mass loading is estimated using contaminant concentrations and stream flow rate.
		The quality of surface water both upstream (WS01SP) and downstream within the Western Drainage (WDAC), also appear to have been affected. Seep/spring samples contain gross alpha particle activities exceeding the MCL. Manganese and sulfate are also elevated above SMCLs at both upstream and downstream locations. pH is below the lower end of the SMCL range.	Determine whether contaminated surface water, sediment, or groundwater may migrate beyond the MA boundary in the future. (see PIA Surface Water/Sediment and Groundwater Decision Flow charts.	Lateral: The portion of the PIA within the Western Drainage, extending southeastward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected bedrock flow path. Temporal: Future conditions up to 1,000 years from present	Maximum future constituent concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundary:			This decision is relevant only if it is determined that contaminated surface water, sediment, or groundwater have not migrated to the PIA, but may in the future. Currently available information strongly indicates that seep/spring water, surface water, sediment, and alluvial and bedrock groundwater in the Western Drainage have been contaminated by the MA. This is likely to be confirmed and better delineated during Phase 1A. Therefore, the decision statement regarding the potential for future migration of contamination to the PIA is probably not relevant. Thus no data collection to support predictive modeling is proposed in Phase 1A.
					1) Information to support flow and fate and transport modeling	None	None	
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur.
		Analytical results from sediment samples collected south of the MA within the Western Drainage indicate the quality of the Western Drainage sediment has been affected by the MA. Manganese is present at concentrations exceeding the Region IX human health PRG (3,100 mg/kg) (maximum concentration is 3,130 mg/kg); and U234, U235, and U238 are observed at concentrations of one order of magnitude above the human health PRGs for soil of 20, 0.16, and 21 pCi/g, respectively.	Select the remedial alternative or alternatives to comply with preliminary ARARs and/or reduce risk to acceptable levels (see FS Decision Flowchart)	Lateral: The portion of the PIA within the Western Drainage, extending southeastward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current and future conditions to 1,000 years from present.	1) Nature and extent of contaminated surface water, sediment, and groundwater in Western Drainage PIA	Same samples as above	VOCs (GW only), SVOCs, metals, radionuclides, inorganics, TPH, other parameters	Based on currently available information, it is expected that remedial alternatives will be evaluated for surface water, sediment, and groundwater in the Western Drainage for cleanup of contamination to meet preliminary ARARs or background, and reduce risks to acceptable levels. Therefore, information is needed to estimate the sources and flow rates of contaminated surface water, the sources and volume of contaminated sediment, and the volume of contaminated groundwater in the Western Drainage PIA for evaluation of alternatives. The constituent concentration and groundwater level information identified above may be adequate to support the FS. Alternatively, additional Phase 2A characterization of the nature and extent of contamination may be required depending on the results of Phase 1A.
		Groundwater samples collected from wells along the Western Drainage also appear to have been affected by the MA. Gross alpha particle activities in groundwater samples			2) Preliminary ARARs and risk-based cleanup levels	None	None	Preliminary ARARs and risk-based cleanup levels are required for determining cleanup levels for contaminated environmental media. Preliminary ARARs have been identified for the site. Risk-based cleanup levels will be developed during baseline human health and ecological risk assessments.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Western Drainage (cont.)		from unconsolidated material wells exceed the MCL. Manganese and sulfate are elevated above SMCLs, and pH is below the lower end of the SMCL range. In the sample from the single bedrock well (GW-50), gross alpha particle and radium activities exceed the MCLs (radium only slightly). Manganese is elevated above the SMCL.			3) Background PCOC concentrations	See background sampling program	See background sampling program	Background concentrations will be required for determining cleanup levels for constituents that naturally occur at concentrations above preliminary ARARs and risk-based cleanup levels. Background constituent concentrations will be determined during the background sampling program, described separately.
					4) Physical properties of natural materials in the Western Drainage PIA	None in Phase 1A	None	Various types of physical property information (e.g., geotechnical properties, hydraulic properties) may be required for conceptual design of remedial alternatives. Such physical property data are typically very site specific. Therefore, no sampling for physical properties will be conducted until remedial alternatives are identified in detail. Additional Phase 2A data collection may be required to address evaluation of specific alternatives.
					5) Information to support flow and fate and transport modeling	None in Phase 1A	None	Various types of flow and fate and transport modeling may be required for conceptual design of remedial alternatives. Such modeling is typically very alternative specific. Therefore, no sampling to support modeling will be conducted until remedial alternatives are identified in detail. Additional Phase 2A data collection may be required to collect modeling information for evaluation of specific alternatives.
					6) Groundwater flow directions and pathways (unconsolidated material and bedrock)	Same water level and streambed measurements as above	Same groundwater and streambed elevations as above	Groundwater flow directions and pathways are likely to be required for conceptual design of remedial alternatives. The groundwater flow directions and pathway data collection described earlier may be adequate. Therefore, no additional Phase 1A data collection is proposed for supporting alternatives evaluations. Phase 2A data collection may be required to address evaluation of specific alternatives to be developed later.
Central Drainage	PIA	The Central Drainage is the downstream extension of the topographic surface drainage that formerly existed within and drained the central portion of the MA. The Central Drainage currently extends from the southern MA boundary, just south of the toe of the South Spoils, to the confluence with the Eastern Drainage approximately 1,800 feet to the south.	Determine whether exposure pathways associated with surface water, sediment, or groundwater are potentially complete and significant for humans or the environment and/or whether ARARs apply (see PIA Surface Water/Sediment and Groundwater Decision Flow Charts).	Lateral: The portion of the PIA within the Central Drainage, extending southeastward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current and future conditions	Human health and ecological CSMs Preliminary ARARs	None None	None None	The CSMs depict the complete and significant exposure pathways for humans and the environment. The CSMs indicate that exposure pathways associated with surface water, sediment, and groundwater are potentially complete and significant. Preliminary ARARs exist for PIA groundwater and surface water.
		Water is discharged to the Central Drainage from seeps/springs located where the drainage is truncated by the central portion of the South Spoils. Water emanating from the seeps/springs is believed to be derived from subsurface flow pathways in the central portion of the MA, including historic drainages now buried by waste rock or stockpile material, possible trans-drainage pathways associated with mine haul roads or other flow barriers, backfilled pits, and bedrock flow pathways.	Determine whether affected surface water, sediment, or groundwater has migrated past the MA boundary in the Central Drainage. (see PIA Surface Water/Sediment and Groundwater Decision Flow charts.	Lateral: The portion of the PIA within the Central Drainage, extending southward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum constituent concentrations for all PCOCs in: <ul style="list-style-type: none">Seep/spring water, sediment, and groundwater at MA boundary along primary flow axis.	Seep/spring water , SW-15, Up to 3 events Sediment , SDGD-01, Up to 2 events Water table GW , MW-2, Up to 3 events Deep Bedrock GW, MWCD-01, Up to 3 events	Metals, radionuclides, inorganics, TPH, other parameters	This decision requires the results of chemical analyses for organic vehicle-related constituents (which do not occur naturally in this environment), and a comparison of naturally-occurring inorganic PCOC constituent concentrations to background concentrations to determine whether the MA has affected these media. Maximum PCOC concentrations in surface water and groundwater are expected to occur along or near the drainage axis and may vary with season. Moreover, the maximum concentrations for all PCOCs may not occur during the same seasons (i.e., some maximum concentrations may occur in the spring and others in the fall). To evaluate maximum PCOC concentrations in the risk assessment, PCOC concentration data are necessary for the high flow (i.e., spring) and low flow (i.e., fall) seasons. To increase the likelihood of measuring the maximum PCOC concentrations in the high flow period, two sampling events are planned. Therefore a total of 3 events are planned for groundwater and surface water sampling (two in the spring and one in the fall). Less than three sampling events are necessary to resolve this decision if the data indicate that vehicle-related organic PCOCs are present or naturally-occurring inorganic PCOC concentrations exceed background levels. Maximum sediment concentrations are expected to occur during the low flow season, when the effects from evaporative deposition of salts may be at a maximum. Therefore, one sampling event for sediment is planned for the fall. Additional sediment samples will be collected as verification samples at locations where PCOC concentrations in samples from the fall event exceed background levels. Currently available information appears to indicate that seep/spring water, surface water, sediment, and alluvial and bedrock groundwater in the Central Drainage have been affected by the MA.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design		
Central Drainage (cont.)		Various truck ready-lines were operated on the top of the South Spoils above the PCP during the mining operations. Soil staining, which may be attributable to spills or leaks, has been identified based on detailed evaluation of aerial photographs (Peters, 1999). A portion of the seep/spring water is contained by a collection and pump back system operated to control migration of water from the MA to the PIA. However, a portion of the seep/spring water escapes down the drainage, particularly during high flow conditions. The Central Drainage receives direct runoff from the eastern portion of the South Spoils and other portions of the Central Drainage watershed within the PIA. The Central Drainage may also receive water as a result of groundwater discharge along its course, either from flow paths in unconsolidated materials or from bedrock.			<ul style="list-style-type: none">Surface water, sediment, and groundwater along length of Central Drainage	Surface water , SWCD-01, Up to 3 events Sediment, SDCD-03, Up to 2 events Water table GW, GW -36A, Up to 3 events Deep Bedrock GW, GW-51, Up to 3 events	Metals, radionuclides, inorganics, TPH, other parameters	Changes in surface water and sediment constituent concentrations may occur with increasing distance from the MA as a result of groundwater discharge, including discharge from deep groundwater pathways. Therefore, surface water (SWCD-01) and sediment (SDCD-03) constituent concentration data are required further down the drainage for use in evaluating the potential for changes in quality as a result of alluvial or bedrock groundwater discharge. Changes in groundwater quality at the water table may occur along the drainage as a result of upward flow of bedrock groundwater, or downward movement of surface water or sediment constituents. Groundwater constituent concentration data from a water table well (GW-36A) will be used to evaluate the potential for changes in groundwater quality at the water table along the drainage as a result of discharging bedrock groundwater or infiltration of surface water or sediment constituents. Progressively deeper bedrock groundwater flow paths may converge upward toward the drainage with increasing distance from the MA. Bedrock groundwater constituent concentration data (GW-51) will be used to evaluate the potential for contamination in deeper bedrock flow paths potentially discharging in the PIA.		
		<ul style="list-style-type: none">Surface water, sediment, and groundwater immediately upstream of confluence with Eastern Drainage			Surface water , SW-12, Up to 3 events Sediment, SDCD-02, Up to 2 events Water table GW, GW-19, Up to 3 events Deep Bedrock GW, MWCD-02, Up to 3 events	Metals, radionuclides, inorganics, TPH, other parameters	Constituent concentration data for surface water (SW-12) and sediment (SDCD-02) upgradient of the confluence with the Eastern Drainage will be used to evaluate the potential for changes in quality with distance from the MA boundary as a result of groundwater discharge. Groundwater constituent concentration data from a water table well GW-19 will be used to evaluate the potential for changes in groundwater quality at the water table along the drainage as a result of discharging bedrock groundwater or infiltration of surface water or sediment constituents. Bedrock groundwater constituent concentration data (MWCD-02) will be used to evaluate the potential for contamination in deeper bedrock flow paths potentially discharging in the PIA.			
		Water table groundwater flow pathways from the central MA are expected to be convergent toward and along the Central Drainage alignment. Groundwater may flow upward to discharge to the drainage, or may receive surface water infiltration from the drainage.			2) Groundwater flow directions and pathways in unconsolidated material and bedrock.	Groundwater elevations, all existing wells in Central Drainage and two new piezometers, MWWD-03 and MWCD-03, 4 seasons Streambed elevations, SW-15, SWCD-01, and SW-12, 1 measurement	Groundwater elevations Streambed elevations	Water table and deeper bedrock groundwater flow is expected to be horizontally convergent toward the drainage axis, but gradients may vary with season. Vertical groundwater flow directions may be upward, downward, or neither and may also vary with season. Based on topography, it is speculated that deeper bedrock flow paths will be upward toward the drainage. Groundwater elevations and stream elevations will be used to estimate horizontal and vertical groundwater flow directions and surface water/groundwater interactions. The two new piezometers, MWWD-03 and MWCD-03, will provide information to assess the hypothesis of convergent horizontal bedrock flow toward the drainage.		
		Deeper bedrock groundwater also possibly converges horizontally and vertically toward the drainage. Therefore, deep bedrock flow paths originating in the MA may discharge along the drainage.			3) Background concentrations for naturally-occurring inorganic PCOCs in surface water, sediment, and ground-water (alluvial and bedrock)	See background sampling program	See background sampling program	This decision involves comparison of potentially affected concentrations for naturally-occurring inorganic constituents to background concentrations. The background sampling program is described separately. For vehicle-related organic constituents (which do not occur naturally in this environment), the presence of the constituents in water or sediment will be sufficient to determine the presence of mine effects.		
		Groundwater flow may also exist along the alignment of the Central Drainage, without interaction with the surface water in the drainage.	Determine whether contaminated surface water, sediment, or groundwater has migrated beyond the MA boundary in the Central Drainage, and conduct baseline risk assessments. (see PIA Surface Water/Sediment and Groundwater Decision Flow charts.	Lateral: The portion of the PIA within the Central Drainage, extending southward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum or 95% UCL PCOC constituent concentrations in seep/spring water, surface water, sediment, and groundwater at or downgradient of the MA boundary (locations as above that indicate mine effects)	Same samples as above with the exception that 3 data collection events (up to 2 events for sediments) are required to support the baseline risk assessments	Metals, radionuclides, inorganics, TPH, other parameters	This decision involves the comparison of maximum or 95% UCL PCOC constituent concentrations to preliminary ARARs and assessment of whether the maximum concentrations pose an unacceptable risk. The constituent concentration information obtained in the previous decision is also used for this decision, but may be supplemented by data for additional seasons. Currently available information strongly indicates that seep/spring water, surface water, sediment, and alluvial and bedrock groundwater in the Central Drainage have been contaminated by the MA.		
		The quality of water emanating from the seeps/springs at the toe of the South Spoils appears to have been affected by the MA. Water from seep/spring sampling location SW-15 contains elevated activities of gross alpha particle and radium several orders of magnitude above MCLs. Manganese and sulfate are elevated above SMCLs. Uranium also appears elevated at an activity of over 15,000 pCi/L.			2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur.		
					3) Surface water flow rate	Temporary flume, all surface water sampling locations identified above, 4 seasons	Surface water flow rate	Estimation of mass loading of contaminants via streams is necessary for the ecological risk assessment. Mass loading is estimated using contaminant concentrations and stream flow rates.		
				Determine whether contaminated surface water, sediment, or groundwater may migrate beyond the MA boundary in the future. (see PIA Surface Water/Sediment and Groundwater Decision Flow charts.	Lateral: The portion of the PIA within the Central Drainage, extending southeastward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path.	Maximum future PCOC constituent concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundary:			This decision is relevant only if it is determined that contaminated surface water, sediment, or groundwater have not migrated to the PIA, but may in the future. Currently available information strongly indicates that seep/spring water, surface water, sediment, and alluvial and bedrock groundwater in the Central Drainage have been contaminated by the MA. This is likely to be confirmed and better delineated during Phase 1A. Therefore, the decision statement regarding the potential for future migration of contamination to the PIA is probably not relevant. Thus no data collection to support predictive modeling is proposed in Phase 1A.	

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Central Drainage (cont.)		The quality of surface water just upstream of the confluence of the Central Drainage and the Eastern Drainage also appears to have been affected. Samples from surface water sampling location SW-12 contain gross alpha particle activities exceeding the MCL. Manganese and sulfate are also elevated above SMCLs. pH is below the lower end of the SMCL range.		Temporal: Future conditions to 1,000 years from present	1) Information to support flow and fate and transport modeling of contamination to the PIA	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur.
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur.
		The quality of sediment appears to have been affected by the MA. Analytical results from sediment samples collected in the northern and central portion of the drainage, downgradient of the MA, indicate the presence of inorganic constituents at concentrations above the preliminary ecological screening values; manganese also exceeds the Region IX human health PRG. Radium 226 (maximum activity of 263 pCi/g, human health PRG for soil is 0.005 pCi/g), U ₂₃₄ , U ₂₃₅ , and U ₂₃₈ are present at concentrations exceeding human health PRGs for soil by one or two orders of magnitude. Concentrations appear to decrease downgradient from the MA. In the southern portion of the drainage, just upgradient of the confluence with the Eastern Drainage, inorganic concentrations do not exceed preliminary ecological screening values, with the exception of manganese, which slightly exceeds the preliminary ecological screening value of 730 mg/kg. Concentrations of U ₂₃₄ , U ₂₃₅ , and U ₂₃₈ slightly exceed the human health PRGs for soil of 20, 0.16, and 21 pCi/g.	Select the remedial alternative or alternatives to comply with preliminary ARARs and/or reduce risk to acceptable levels (See FS Decision Flow Chart)	Lateral: The portion of the PIA within the Central Drainage, extending southeastward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions and future conditions to 1,000 years from present	1) Nature and extent of contaminated surface water, sediment, and groundwater in Central Drainage PIA	Same samples as above	Metals, radionuclides, inorganics, TPH, other parameters	Based on currently available information regarding the potential for contamination, it is expected that remedial alternatives will be evaluated for surface water, sediment, and groundwater in the Central Drainage for cleanup of contamination to meet preliminary ARARs or background, and reduce risks to acceptable levels. Therefore, information is needed to estimate the sources and flow rates of contaminated surface water, the sources and volume of contaminated sediment, and the volume of contaminated groundwater in the Central Drainage PIA for evaluation of alternatives. The constituent concentration and groundwater level information identified above may be adequate to support the FS. Alternatively, additional Phase 2A characterization of the nature and extent of contamination may be required depending on the results of Phase 1A.
					2) Preliminary ARARs and risk-based cleanup levels	None	None	Preliminary ARARs and risk-based cleanup levels are required for determining cleanup levels for contaminated environmental media. Preliminary ARARs have been identified for the site. Risk-based cleanup levels will be developed during baseline human health and ecological risk assessments.
		Groundwater samples collected from wells along the Central Drainage also appear to have been affected by the MA. Gross alpha particle activities in groundwater samples from unconsolidated material wells exceed the MCL. Manganese and sulfate are elevated above SMCLs. In the sample from the single bedrock well (GW-51), gross alpha particle activities exceed the MCL. Sulfate is elevated above the SMCL.			3) Background PCOC concentrations	See background sampling program	See background sampling program	Background concentrations will be required for determining cleanup levels for constituents that naturally occur at concentrations above preliminary ARARs and risk-based cleanup levels. Background constituent concentrations will be determined during the background sampling program, described separately.
					4) Physical properties of natural materials in the Central Drainage PIA	None in Phase 1A	None	Various types of physical property information (e.g., geotechnical properties, hydraulic properties) may be required for conceptual design of remedial alternatives. Such physical property data are typically very site specific. Therefore, no sampling for physical properties will be conducted until remedial alternatives are identified in detail. Additional Phase 2A data collection may be required to address evaluation of specific alternatives.
					5) Information to support flow and fate and transport modeling	None in Phase 1A	None	Various types of flow and fate and transport modeling may be required for conceptual design of remedial alternatives. Such modeling is typically very alternative specific. Therefore, no sampling to support modeling will be conducted until remedial alternatives are identified in detail. Additional Phase 2A data collection may be required to collect modeling information for evaluation of specific alternatives.
					6) Groundwater flow directions and pathways (unconsolidated material and bedrock)	Same water level and streambed measurements as above	Same groundwater and streambed elevations as above	Groundwater flow directions and pathways are likely to be required for conceptual design of remedial alternatives. The groundwater flow directions and pathway data collection described earlier may be adequate. Therefore, no additional Phase 1A data collection is proposed for supporting alternatives evaluations. Phase 2A data collection may be required to address evaluation of specific alternatives to be developed later.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Eastern Drainage	PIA	The Eastern Drainage is the topographic surface drainage that exists immediately east of the southeastern portion of the MA. The Eastern Drainage is herein defined to extend from the Midnite Mine NPDES outfall (i.e., located just north of the northernmost extent of the mine haul road) to the confluence with Blue Creek, approximately 6,400 feet to the south. The Eastern Drainage also includes two northwest-southeast trending tributary drainages extending from the MA boundary to the main drainage. The western of these tributaries contains the East Seep Pumpback System.	Determine whether exposure pathways associated with surface water, sediment, or groundwater are potentially complete and significant for humans or the environment and/or whether ARARs apply (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Eastern Drainage, extending southward to the confluence with Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current and future conditions	Human health and ecological CSMs Preliminary ARARs	None None	None None	The CSMs depict the complete and significant exposure pathways for humans and the environment. The CSMs indicate that exposure pathways associated with surface water, sediment, and groundwater are potentially complete and significant. Preliminary ARARs exists for PIA groundwater and surface water.
		Surface water is discharged to the Eastern Drainage from the upstream Northeastern Drainage, and from the Midnite Mine NPDES outfall located immediately north of the east haul road. Water also enters the drainage from the East Seep. Water emanating from the seep/spring is believed to be derived from subsurface flow pathways in the eastern portion of the MA, including historic drainages now buried by waste rock or stockpile material, possible trans-drainage pathways associated with mine haul roads or other flow barriers, and bedrock flow pathways. A truck staging area was operated immediately north of the current location of the water treatment plant during the later stages of mining. Soil staining, possibly attributable to spills or leaks, has been identified based on detailed evaluation of aerial photographs (Peters, 1999).	Determine whether affected surface water, sediment, or groundwater has migrated past the MA boundaries along the Eastern Drainage. (For this evaluation, the NPDES outfall is considered an MA boundary) (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Eastern Drainage, extending southward to the confluence with Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum constituent concentrations for all PCOCs in: <ul style="list-style-type: none">Seep/spring water, surface water, sediment, and groundwater at MA boundaries along primary flow axes (3 locations).	NPDES Outfall MA boundary: Surface water , OF01SW, Up to 3 events Sediment , SDED-01, Up to 2 events Sediment , SDED-07, Up to 2 events Water table GW, MWED-01, Up to 3 events Deep Bedrock GW, MWED-02, Up to 3 events MA boundary east of Blood Pool: Shallow bedrock GW, MWED-09, Up to 3 events Unnamed drainage south of WTP: Water table GW , MWED-05, Up to 3 events Deep Bedrock GW, MWED-06, Up to 3 events East Seep/Spring drainage: Seep/spring water, East Seep, Up to 3 events Sediment, SDED-05, Up to 2 events Water table GW, MWED-07 Up to 3 events Deep Bedrock GW, MWED-08, Up to 3 events	Metals, radionuclides, inorganics, TPH, other parameters	This decision requires the results of chemical analyses for vehicle-related organic constituents (which do not occur naturally in this environment), and a comparison of naturally-occurring inorganic PCOC constituent concentrations to background concentrations to determine whether the MA has affected these media. Maximum PCOC concentrations in surface water and groundwater are expected to occur along or near the drainage axis and may vary with season. Moreover, the maximum concentrations for all PCOCs may not occur during the same seasons (i.e., some maximum concentrations may occur in the spring and others in the fall). To evaluate maximum PCOC concentrations in the risk assessment, PCOC concentration data are necessary for the high flow (i.e., spring) and low flow (i.e., fall) seasons. To increase the likelihood of measuring the maximum PCOC concentrations in the high flow period, two sampling events are planned. Therefore a total of 3 events are planned for groundwater and surface water sampling (two in the spring and one in the fall). Less than three sampling events are necessary to resolve this decision if the data indicate that vehicle-related organic PCOCs are present or naturally-occurring inorganic PCOC concentrations exceed background levels. The sampling events will be scheduled so that the effects of discharge from the WTP on water quality in the drainage can be evaluated. The fall sampling event and the second spring event will coincide with WTP discharge. The first spring sampling event will occur during a period of zero WTP discharge. Maximum sediment concentrations are expected to occur during the low flow season, when the effects from evaporative deposition of salts may be at a maximum. Therefore, one sampling event for sediment is planned for the fall. Additional sediment samples will be collected as verification samples at locations where PCOC concentrations in samples from the fall event exceed background levels. Currently available information appears to indicate that seep/spring water, surface water, sediment, and alluvial and bedrock groundwater in the Eastern Drainage have been affected by the MA.
		A portion of the seep/spring water at the East Seep is contained by a collection and pump back system operated to control migration of water from the MA to the PIA. A portion of the seep/spring water may escape down the drainage, especially during high flow conditions.			<ul style="list-style-type: none">Surface water, sediment, and groundwater along length of Eastern Drainage	Surface water, SW-2, Up to 3 events Sediment, SDED-06, Up to 2 events Surface water , ED-2, Up to 3 events Sediment, ED04SD, Up to 2 events Surface Water, ED-4, Up to 3 events Sediment, SDED-02, Up to 2 events Water table GW, MW-5, Up to 3 events Deep bedrock GW, MWED-03, Up to 3 events Surface water, SWED-01, Up to 3 events Sediment, SDED-03, Up to 2 events Water table GW, MW-4, Up to 3 events Deep bedrock GW, MWED-04, Up to 3 events Surface water, SWED-02, Up to 3 events Sediment, SDED-04, Up to 2 events	Metals, radionuclides, inorganics, TPH, other parameters	Changes in surface water and sediment constituent concentrations may occur with increasing distance from the MA as a result of groundwater discharge, including discharge from deep groundwater flowpaths. Therefore, surface water (SW-2, ED-2, ED-4, SWED-01, and SWED-02) and sediment (SDED-06, ED04SD, SDED-02, SDED-03, and SDED-04) constituent concentration data are required further down the drainage for use in evaluating the potential for changes in quality as a result of alluvial or bedrock groundwater discharge. Changes in groundwater quality at the water table may occur along the drainage as a result of upward flow of bedrock groundwater, or downward movement of surface water or sediment constituents. Groundwater constituent concentration data from water table wells (MW-5 and MW-4) will be used to evaluate the potential for changes in groundwater quality at the water table along the drainage as a result of discharging bedrock groundwater or infiltration of surface water or sediment constituents. Progressively deeper bedrock groundwater flow paths may converge upward toward the drainage with increasing distance from the MA. Bedrock groundwater constituent concentration data (MWED-03 and MWED-04) will be used to evaluate the potential for contamination in deeper bedrock flow paths potentially discharging in the PIA.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design	
Eastern Drainage (cont.)		The Eastern Drainage also receives direct runoff from waste rock deposited along the southeast MA boundary. The Eastern Drainage may also receive water as a result of groundwater discharge along its course, either from flow paths in unconsolidated materials or from bedrock. Water table groundwater flow pathways from a portion of the eastern MA are expected to be toward and along the Eastern Drainage alignment. Groundwater may flow upward to discharge to the drainage, or may receive surface water infiltration from the drainage. Deeper bedrock groundwater also possible converges horizontally and vertically toward the drainage. Therefore, deep bedrock flow paths originating in the MA may discharge along the drainage. Groundwater flow may also exist along the alignment of the Eastern Drainage, without interaction with the surface water in the drainage.			<ul style="list-style-type: none">Surface water, sediment, and groundwater immediately upstream of confluence with Blue Creek	Surface water , SW-6, Up to 3 events Sediment, ED01SD, Up to 2 events Water table GW, MWED-11, Up to 3 events Deep bedrock GW, MWED-10, Up to 3 events	Metals, radionuclides, inorganics, TPH, other parameters	Constituent concentration data for surface water (SW-6) and sediment (ED01SD) upgradient of the confluence with Blue Creek will be used to evaluate the potential for changes in quality as a result of groundwater discharge. Groundwater constituent concentration data from a water table well (MWED-10) will be used to evaluate the potential for changes in groundwater quality at the water table along the drainage as a result of discharging bedrock groundwater or infiltration of surface water or sediment constituents. Bedrock groundwater constituent concentration data (MWED-11) will be used to evaluate the potential for contamination in deeper bedrock flow paths potentially discharging in the PIA.	
					2) Groundwater flow directions and pathways in unconsolidated material and bedrock.	Groundwater elevations, all existing wells in Eastern Drainage and MWCD-03, 4 seasons Streambed elevations, OF01SW, SW-2, ED-2, ED-4, SWED-01, SWED-02, and SW-6, 1 measurement	Groundwater elevations Streambed elevations	Water table and deeper bedrock groundwater flow is expected to be horizontally convergent toward the drainage axes, but gradients may vary with season. Based on topography, it is speculated that deeper bedrock flowpaths will be upward toward the drainage. Vertical groundwater flow directions may be upward, downward, or neither and may also vary with season. Groundwater elevations and stream elevations will be used to estimate horizontal and vertical groundwater flow directions and surface water/groundwater interactions. MWCD-03 will provide information to assess the hypothesis of convergent horizontal bedrock flow toward the Eastern Drainage.	
					3) Background concentrations for naturally-occurring inorganic PCOCs in seep water, surface water, sediment, and groundwater (alluvial and bedrock)	See background sampling program	See background sampling program	This decision involves comparison of potentially affected concentrations for naturally-occurring inorganic constituents to background concentrations. The background sampling program is described separately. For vehicle-related organic constituents (which do not occur naturally in this environment), the presence of the constituents in water or sediment will be sufficient to determine the presence of mine effects.	
		The quality of water emanating from the East Seep appears to have been affected by the MA. Water from the East Seep sampling location contains elevated activities of gross alpha particle and radium in excess of MCLs. Manganese and sulfate are elevated above SMCLs. pH is below the lower end of the SMCL range. Uranium also appears elevated at a concentration of over 3,400 pCi/L.	Determine whether contaminated surface water, sediment, or groundwater has migrated beyond the MA boundaries to the Eastern Drainage and its tributaries, and conduct baseline risk assessments. (For this evaluation, the NPDES outfall is considered an MA boundary.) (See PIA Surface Water/Sediment and Groundwater Decision Flow charts.)	Lateral: The portion of the PIA within the Eastern Drainage, extending southward to the confluence with the Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum or 95% UCL PCOC constituent concentrations in seep/spring water, surface water, sediment, and groundwater at or downgradient of the MA boundary (locations as above that indicate mine effects)	Same samples as above with the exception that 3 data collection events (2 events for sediments) are required to support the baseline risk assessments	Metals, radionuclides, inorganics, TPH, other parameters	This decision involves the comparison of maximum or 95% UCL PCOC constituent concentrations to preliminary ARARs and assessment of whether the maximum concentrations pose an unacceptable risk. The constituent concentration information obtained in the previous decision is also used for this decision, but may be supplemented by data for additional seasons. Currently available information strongly indicates that seep/spring water, surface water, sediment, and alluvial and bedrock groundwater in the Eastern Drainage have been contaminated by the MA.	
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur.	
					3) Surface water flow rate	Temporary flume, all surface water sampling locations identified above, 4 seasons	Surface water flow rate	Estimation of mass loading of contaminants via streams is necessary for the ecological risk assessment. Mass loading is estimated using contaminant concentrations and stream flow rates.	
		The quality of surface water in the Eastern Drainage also appears to have been affected. Samples from surface water sampling locations SW-2 and SW-11, both located above the confluences with the Western or Central Drainages, contain gross alpha particle at activities exceeding the MCL. Sulfate is also elevated above the SMCL.	Determine whether contaminated surface water, sediment, or groundwater may migrate beyond the MA boundaries in the future (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Eastern Drainage, extending southeastward to the confluence with Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path.	Maximum future PCOC constituent concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundaries: 1) Information to support flow and fate and transport modeling	None	None	This decision is relevant only if it is determined that contaminated surface water, sediment, or groundwater have not in migrated to the PIA, but may in the future. Currently available information strongly indicates that seep/spring water, surface water, sediment, and alluvial and bedrock groundwater in the Eastern Drainage and its tributaries have been contaminated and/or affected by the MA. This is likely to be confirmed and better delineated during Phase 1A. Therefore, the decision statement regarding the potential for future migration of contamination to the PIA is probably not relevant. Thus no data collection is required in Phase 1A.	
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur.	
		The sediment within the Eastern Drainage appears to be affected by several tributaries, which are affected by the MA. Upstream of the northernmost tributary, only manganese and radium 228 are present at concentrations above the preliminary ecological screening value, and human health PRG for soil, respectively. However, several inorganic		Select the remedial alternative or alternatives to comply with preliminary ARARs and/or reduce risk to acceptable levels (See FS Decision Flow Chart)	Lateral: The portion of the PIA within the Eastern Drainage, extending southeastward to the confluence with the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path.	2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur.
						1) Nature and extent of contaminated surface water, sediment, and groundwater in the Eastern Drainage PIA	Same samples as above	Metals, radionuclides, inorganics, TPH, other parameters	Based on currently available information regarding the potential for contamination, it is expected that remedial alternatives will be evaluated for surface water, sediment, and groundwater in the Eastern Drainage for cleanup of contamination to meet preliminary ARARs or background, and reduce risks to acceptable levels. Therefore, information is needed to estimate the sources and flow rates of contaminated surface water, the sources and volume of contaminated sediment, and the volume of contaminated groundwater in the Eastern Drainage PIA for evaluation of alternatives. The constituent concentration and groundwater level information identified above may be adequate to support the FS. Alternatively, additional Phase 2A characterization of the nature and extent of contamination may be required depending on the results of Phase 1A.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Eastern Drainage (cont.)		constituents are present in sediments at locations downgradient of the confluence of the northernmost tributary and the Central Drainage at concentrations exceeding the preliminary ecological screening values. Manganese is present at concentrations exceeding the preliminary ecological screening value of 730 mg/kg at sample locations upstream of the confluence with the Central Drainage, but manganese concentrations exceed the Region IX human health PRG of 3,100 mg/kg downstream of this confluence. Radium and uranium isotopes are present in sediment at several locations along the Eastern Drainage at concentrations exceeding the human health PRGs for soil. Their presence and concentration may be influenced by contaminated materials coming from the tributaries. The maximum radium 226 activity (12.9 pCi/g; human health PRG for soil is 0.005 pCi/g) was in a sample collected just downstream of the confluence with the northernmost tributary. The maximum U ₂₃₅ activity (4.2 pCi/g; human health PRG for soil is 0.16 pCi/g) was in a sample collected just downstream of the confluence with the Central Drainage. Groundwater samples collected from wells along the Eastern Drainage upstream of the confluences with the Western and Central Drainages also appear to have been affected by the MA. Gross alpha particle activity in samples from MW-4 exceed the MCL.		Temporal: Current conditions and future conditions to 1,000 years from present	2) ARARs and risk cleanup levels	None	None	Preliminary ARARs and risk-based cleanup levels are required for determining cleanup levels for contaminated environmental media. Preliminary ARARs have been identified for the site. Risk-based cleanup levels will be developed during baseline human health and ecological risk assessments.
					3) Background PCOC concentrations	See background sampling program	See background sampling program	Background concentrations will be required for determining cleanup levels for constituents that naturally occur at concentrations above preliminary ARARs and risk-based cleanup levels. Background constituent concentrations will be determined during the background sampling program, described separately.
					4) Physical properties of natural materials in the Eastern Drainage PIA)	None in Phase 1A	None	Various types of physical property information (e.g., geotechnical properties, hydraulic properties) may be required for conceptual design of remedial alternatives. Such physical property data are typically very site specific. Therefore, no sampling for physical properties will be conducted until remedial alternatives are identified in detail. Additional Phase 2A data collection may be required to address evaluation of specific alternatives.
					5) Information to support flow and fate and transport modeling	None in Phase 1A	None	Various types of flow and fate and transport modeling may be required for conceptual design of remedial alternatives. Such modeling is typically very alternative specific. Therefore, no sampling to support modeling will be conducted until remedial alternatives are identified in detail. Additional Phase 2A data collection may be required to collect modeling information for evaluation of specific alternatives.
					6) Groundwater flow directions and pathways (unconsolidated material and bedrock)	Same water level and streambed measurements as above	Same groundwater and streambed elevations as above	Groundwater flow directions and pathways are likely to be required for conceptual design of remedial alternatives. The groundwater flow directions and pathway data collection described earlier may be adequate. Therefore, no additional Phase 1A data collection is proposed for supporting alternatives evaluations. Phase 2A data collection may be required to address evaluation of specific alternatives to be developed later.
Northeastern Drainage	PIA	The Northeastern Drainage is the topographic surface drainage that exists immediately east of the majority of the northern portion of the MA. The Northeastern Drainage consists of all surface drainages that intersect the eastern MA boundary between the top of the Pit 4 headwall and the Midnite Mine NPDES outfall (i.e., which serves as the boundary between the Northeastern Drainage and the Eastern Drainage).	Determine whether exposure pathways associated with surface water, sediment, or groundwater are potentially complete and significant for humans or the environment, and/or whether ARARs apply (see PIA Surface Water/ Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Northeastern Drainage, extending southward to the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current and future conditions	Human health and ecological CSMs	None	None	The CSMs depict the complete and significant exposure pathways for humans and the environment. The CSMs indicate that exposure pathways associated with surface water, sediment, and groundwater are potentially complete and significant.
					Preliminary ARARS	None	None	Preliminary ARARS exist for PIA groundwater and surface water.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Northeastern Drainage (cont.)		Surface water runoff and groundwater enters the Northeastern Drainage from the northern portion of the MA south of the top of the Pit 4 headwall. The drainage receives direct runoff from waste rock deposited east of the northern portion of Pit 4. This area of waste rock is known to be eroding into the Northeastern Drainage.	Determine whether affected surface water, sediment, or groundwater has migrated past the MA boundary along the Northeastern Drainage (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Northeastern Drainage, extending southward to the Eastern Drainage Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum constituent concentrations for all PCOCs in: <ul style="list-style-type: none">Surface water, sediment, and groundwater at MA boundary downgradient of potential contaminant sources (i.e., Pit 4, the Pit 4 Dump, the Pit 4 Truck Ready-Line, and Pit 3).	<u>Downgradient of Pit 4 and Pit 4 Dump:</u> Surface water , SWNE-02, Up to 3 events Sediment , SDNE-01, Up to 2 events Water table GW, MWNE-01, Up to 3 events Deep bedrock GW, MWNE-02, Up to 3 events	Metals, radionuclides, inorganics, other parameters	This decision requires the results of chemical analyses for organic vehicle-related constituents (for Pit 4 Truck Ready-Line only), and a comparison of naturally-occurring inorganic PCOC concentrations to background concentrations to determine whether the MA has affected these media. Maximum constituent concentrations in surface water, and groundwater within the Northeastern Drainage are expected to occur immediately downgradient of potential contaminant sources in the northern portion of the MA, including Pit 4, the Pit 4 Dump, the Pit 4 Truck Ready-Line, and Pit 3, and may vary with season. A total of 3 events are planned for groundwater and surface water sampling (two in the spring and one in the fall). Less than three sampling events are necessary to resolve this decision if the data indicate that naturally-occurring inorganic PCOC concentrations exceed background levels. Maximum sediment concentrations are expected to occur during the low flow season, when the effects from evaporative deposition of salts may be at a maximum. Therefore, one sampling event for sediment is planned for the fall. Additional sediment samples will be collected as verification samples at locations where PCOC concentrations in samples from the fall event exceed background levels. Currently available information is not sufficient to indicate whether surface water, sediment, or bedrock groundwater in the Northeastern Drainage have been affected by the MA.
		The Northeastern Drainage also receives direct runoff from disturbed natural material, including a former mine truck ready-line east of the southern portion of Pit 4.				<u>Downgradient of Pit 4 and Pit 4 Truck Ready-Line:</u> Water table GW , MWNE-03, Up to 3 events Deep bedrock GW, MWNE-04, Up to 3 events <u>Pit 3:</u> Deep bedrock GW, MWNE-07, Up to 3 events	Metals, radionuclides, inorganics, TPH, other parameters Metals, radionuclides, inorganics, other parameters	Only groundwater information is required downgradient of the Pit 4 Truck Ready-Line because no surface drainage is present there. Also, TPH analytes are required for the Pit 4 Truck Ready-Line because of the potential for release of petroleum compounds and used oil. Groundwater flow from the vicinity of or north of Pit 3 may be directed toward the Northeastern Drainage. Well MWNE-07 will be placed to monitor this potential flow path.
		Bedrock groundwater from the portion of the MA north of Pit 3 and east of Pit 4 may flow toward the Northeastern Drainage, however it is unclear to what degree the hydraulic sink effects of Pit 3 and Pit 4 may influence groundwater flow directions. For instance, immediately east of Pit 3 and Pit 4, it is unknown whether the bedrock groundwater hydraulic gradients are toward the Northeastern Drainage or toward Pit 3 and Pit 4.			<ul style="list-style-type: none">Surface water, sediment, and groundwater upgradient of the boundary between the Northeastern and Eastern Drainages (i.e., the Mine Haul Road)	Surface water, SWNE-03, Up to 3 events Sediment, SDNE-03, Up to 2 events Water table GW , MWNE-05, Up to 3 events Deep Bedrock GW, MWNE-06, Up to 3 events	Metals, radionuclides, inorganics, TPH, other parameters	Deep groundwater flow paths may extend from the MA to the Northeastern Drainage where they may rise to discharge to surface water or alluvial groundwater, or may extend southward into the Eastern Drainage. Therefore, surface water (SWNE-03) and sediment (SDNE-03) constituent concentration data are required further down the drainage for use in evaluating the potential for changes in quality as a result of alluvial or bedrock groundwater discharge. Impacts to alluvial groundwater quality may occur downstream in the drainage as a result of upward flow of bedrock groundwater into the alluvium, or downward movement of surface water or sediment constituents into the alluvium. Alluvial groundwater constituent concentration data (MWNE-05) will be used to evaluate the potential for impacts to alluvial groundwater quality as a result of discharging bedrock groundwater or infiltration of surface water or sediment constituents. Bedrock groundwater constituent concentration data (MWNE-06) will be used to evaluate the potential for contamination in southward-oriented bedrock flow paths from the Northeastern Drainage to the Eastern Drainage.
		Analytical results from only a few surface water, sediment, and groundwater-sampling locations are available from which to evaluate the potential impacts on this area from the MA.			2) Groundwater flow directions and pathways in unconsolidated material and bedrock.	Groundwater elevations, all existing and new wells in Northeastern Drainage, 4 seasons Streambed elevations, SWNE-02, SWNE-03, 1 measurement	Groundwater elevations Streambed elevations	Bedrock horizontal groundwater flow is expected to be from the eastern portion of the northern MA toward the Northeastern Drainage and then southward along the Northeastern Drainage to the Eastern Drainage. East of Pit 4, bedrock hydraulic gradients may be downward and eastward, but may also be influenced by the hydraulic sink effect of Pit 4. Similarly, east of Pit 3, groundwater flow may be toward the Northeastern Drainage, but may also be influenced by the hydraulic sink effect of Pit 3. Saturated alluvium is expected to occur in the lower elevation portions of the drainage, particularly north of the Eastern Drainage. Groundwater flow direction in the alluvium is expected to be southward toward the Eastern Drainage. Groundwater data from bedrock wells along the MA boundary east of Pit 4 (MWNE-01, MWNE-02, MWNE-03, MWNE-04) are expected to demonstrate the eastward and downward gradient east of Pit 4. Groundwater data from the bedrock well along the MA boundary east of Pit 3 (MWNE-07) are expected to resolve the direction of the gradient east of Pit 3. Groundwater data from the alluvial and bedrock wells at the southern end of the Northeastern Drainage (MWNE-05 and MWNE-06), along with hydraulic head data for the Eastern Drainage, are expected to confirm the southward gradient toward the Eastern Drainage.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Northeastern Drainage (cont.)		Manganese at a concentration of 0.37 mg/L is an order of magnitude greater than the SMCL of 0.05 mg/L. U ₂₃₄ and U ₂₃₈ were present at activities one order of magnitude greater than the human health PRG for drinking water (1.1 pCi/L). Background concentrations are not available; however, a surface water sample collected east of this location, and potentially upgradient of the MA, also had elevated concentrations of aluminum, manganese, and total uranium.			3) Background concentrations for naturally-occurring inorganic PCOCs in surface water, sediment, and groundwater (alluvial and bedrock)	See background sampling program	See background sampling program	This decision involves comparison of potentially affected concentrations for naturally-occurring inorganic constituents to background concentrations. The background sampling program is described separately. For vehicle-related organic constituents (which do not occur naturally in this environment), the presence of the constituents in water or sediment will be sufficient to determine the presence of mine effects.
					1) Maximum or 95% UCL PCOC constituent concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundary (locations as above that indicate mine effects)	Same samples as above with the exception that 3 data collection events (2 events for sediments) are required to support the baseline risk assessments	Metals, radionuclides, inorganics, TPH, other parameters	This decision involves the comparison of maximum or 95% UCL PCOC constituent concentrations to preliminary ARARs and assessment of whether the maximum concentrations pose an unacceptable risk. The constituent concentration information obtained in the previous decision is also used for this decision, but may be supplemented by data for additional seasons. Currently available information is not sufficient to determine whether the Northeastern Drainage has been affected or contaminated by the MA.
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur if mine effects are detected in the Northeastern Drainage.
		Several inorganic constituents were present in a sediment sample collected immediately upgradient of the defined boundary of the East Drainage at concentrations that exceeded the preliminary ecological screening value or the Region IX human health PRGs. The Radium 228 activity slightly exceeded the human health PRG for soil of 3.9 pCi/g, and U ₂₃₄ , U ₂₃₅ , and U ₂₃₈ were present at activities approximately one order of magnitude greater than the human health PRG for soil of 1.1 pCi/g.	Determine whether contaminated surface water, sediment, or groundwater has migrated beyond the MA boundaries along the Northeastern Drainage, and conduct (see PIA Surface Water/ baseline risk assessments Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Northeastern Drainage, extending southward to the Eastern Drainage. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	3) Surface water flow rate	Temporary flume, all surface water sampling locations identified above, 4 seasons	Surface water flow rate	Estimation of mass loading of contaminants via streams is necessary for the ecological risk assessment. Mass loading is estimated using contaminant concentrations and stream flow rates.
					Maximum future PCOC concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundary:			This decision is relevant only if it is determined that contaminated surface water, sediment, or groundwater have not migrated to the PIA, but may in the future. Currently available information is not sufficient to determine whether contamination has migrated to the Northeastern Drainage. Thus it is not known at this time whether this decision is relevant for the Northeastern Drainage or not.
					1) Information to support flow and fate and transport modeling	None in Phase 1A	None	The decision regarding whether predictive modeling will be necessary will depend on whether contamination is detected in the Northeastern Drainage in Phase 1A. Thus no data collection to support predictive modeling is proposed in Phase 1A.
Northern Drainage	PIA	The Northern Drainage is the topographic surface drainage that exists immediately east of the northernmost portion of the MA. The Northern Drainage consists of the surface drainage that drains the MA north of Pit 4. Surface water runoff and groundwater enters the Northern Drainage from the northern portion of the MA north of the top of the Pit 4 headwall. The drainage receives direct runoff from disturbed natural material, including exposed mineralized rock.	Determine whether exposure pathways associated with surface water, sediment, or groundwater are potentially complete and significant for humans or the environment, and/or whether ARARs apply (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Northern Drainage, extending southeastward to the confluence with Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current and future conditions	Human health and ecological CSMs	None	None	The CSMs depict the complete and significant exposure pathways for humans and the environment. The CSMs indicate that exposure pathways associated with surface water, sediment, and groundwater are potentially complete and significant.
					Preliminary ARARS	None	None	Preliminary ARARS exist for PIA groundwater and surface water.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Northern Drainage (cont.)		Bedrock groundwater from the portion of the MA north of Pit 4 may flow toward the Northern Drainage or may flow toward Pit 4. It is also possible that a component of groundwater from the northern portion of the MA may flow toward the Sand Creek drainage to the northwest.	Determine whether affected surface water, sediment, or groundwater has migrated past the MA boundary to the Northern Drainage (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Northern Drainage, extending southeastward to the confluence with Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum constituent concentrations for all PCOCs in surface water, sediment, and groundwater at MA boundary downgradient of potential contaminant sources (i.e., exposed mineralized rock).	Surface water , SWND-01, Up to 3 events Sediment , SDND-01, Up to 2 events Water table bedrock GW, MWND-01, Up to 3 events	Metals, radionuclides, inorganics, other parameters	This decision requires a comparison of PCOC constituent concentrations to background concentrations to determine whether the MA has affected these media. Maximum constituent concentrations in surface water and groundwater within the Northern Drainage are expected to occur immediately downgradient of potential contaminant sources in the northern portion of the MA, including areas of exposed mineralized rock, and may vary with season. A total of 3 events are planned for groundwater and surface water sampling (two in the spring and one in the fall). Less than three sampling events are necessary to resolve this decision if the data indicate that naturally-occurring inorganic PCOC concentrations exceed background levels. Maximum sediment concentrations are expected to occur during the low flow season, when the effects from evaporative deposition of salts may be at a maximum. Therefore, one sampling event for sediment is planned for the fall. Additional sediment samples will be collected as verification samples at locations where PCOC concentrations in samples from the fall event exceed background levels. Currently available information is not sufficient to indicate whether surface water, sediment, or bedrock groundwater in the Northern Drainage have been affected by the MA.
					2) Groundwater flow directions and pathways.	Groundwater elevations, MWND-01, 4 seasons	Groundwater elevations	Bedrock groundwater flow paths may extend from the MA to the Northern Drainage or may be oriented toward Pit 4. Water levels in this well are expected to support resolution of the direction of groundwater flow.
		The quality of water, sediment, and groundwater in the Northern Drainage area cannot be assessed because no analytical data are available.	Determine whether contaminated surface water, sediment, or groundwater has migrated beyond the MA boundaries to the Northern Drainage, and conduct baseline risk assessments see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Northern Drainage, extending southeastward to the confluence with Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	3) Background concentrations for PCOCs in surface water, sediment, and groundwater.	See background sampling program	See background sampling program	This decision involves comparison of potentially affected concentrations for naturally-occurring inorganic constituents to background concentrations. The background sampling program is described separately.
					1) Maximum PCOC constituent concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundary (locations as above that indicate mine effects)	Same samples as above with the exception that 3 data collection events of data (up to 2 events for sediments) are required to support the baseline risk assessments.	Metals, radionuclides, inorganics, other parameters	This decision involves the comparison of maximum PCOC constituent concentrations to preliminary ARARs and assessment of whether the maximum concentrations pose an unacceptable risk. The constituent concentration information obtained in the previous decision is also used for this decision, but may be supplemented by data for additional seasons. Currently available information is not sufficient to determine whether the Northern Drainage has been affected or contaminated by the MA.
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur if mine effects are detected in the Northern Drainage.
					3) Surface water flow rate	Temporary flume, SWND-01, 4 seasons	Surface water flow rate	Estimation of mass loading of contaminants via streams is necessary for ecological risk assessment. Mass loading is estimated using contaminant concentrations and stream flow rates.
		Determine whether contaminated surface water, sediment, or groundwater may migrate beyond the MA boundary to the Northern Drainage in the future see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Northern Drainage, extending southeastward to the confluence with Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Future conditions to 1,000 years from present	Maximum future constituent concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundary:				This decision is relevant only if it is determined that contaminated surface water, sediment, or groundwater have not migrated to the Northern Drainage PIA, but may in the future. Currently available information is not sufficient to determine whether contamination has migrated to the Northern Drainage. Thus it is not known at this time whether this decision is relevant for the Northern Drainage or not.
					1) Information to support flow and fate and transport modeling (see table)	None in Phase 1A	None	The decision regarding whether predictive modeling will be necessary will depend on whether contamination is detected in the Northern Drainage in Phase 1A. Thus no data collection to support predictive modeling is proposed in Phase 1A.
					2) Preliminary ARARs and risk assessment results	None	None	

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Northwest Ridge	PIA	<p>The Northwest Ridge consists of the topographic ridge north and northwest of the MA that separates the MA from the Sand Creek drainage.</p> <p>The majority of the Northwest Ridge is outside and uphill from the MA. Surface water runoff from the majority of the Northwest Ridge flows toward the MA, but is diverted from entering the MA by several berms and diversion ditches.</p> <p>A small portion of the Northwest Ridge is adjacent to the area of exposed mineralized rock at the extreme northern end of the MA. In this area, there is the potential for runoff from the MA to the Northwest Ridge.</p>	<p>Determine whether exposure pathways associated with groundwater are potentially complete and significant for humans or the environment, and/or whether ARARs apply (see PIA Groundwater Decision Flow Charts).</p>	<p>Lateral: The portion of the PIA. extending from the MA boundary past the Northwest Ridge to the Sand Creek drainage.</p> <p>Vertical: From ground surface to the deepest affected groundwater flow path.</p> <p>Temporal: Current and future conditions</p>	Human health and ecological conceptual site models (CSMs)	None	None	<p>The CSMs depict the complete and significant exposure pathways for humans and the environment. The CSMs indicate that exposure pathways associated with groundwater are potentially complete and significant.</p>
		Preliminary ARARS			None	None	<p>Preliminary ARARS exist for PIA groundwater and surface water.</p>	
		<p>Based on topographic conditions, the Northwest Ridge is expected to be a groundwater divide. Along the small segment of the Northwest Ridge overlain by the exposed mineralized rock portion of the MA, bedrock groundwater may flow northward from the MA toward the Sand Creek drainage. However, the majority of the MA is down slope to the south from the Northwest Ridge, and bedrock groundwater in these portions of the MA is not expected to flow northward toward the Northwest Ridge or the Sand Creek drainage. However, the possibility exists that groundwater may flow in this direction from the extreme northern MA if the groundwater divide has been shifted southward due to the presence of the Pit 4 lake, or if geological structural features (e.g., the contact between the metasedimentary and the igneous rocks) have resulted in localized high permeability zones oriented northward. The presence of groundwater seeps on the north-facing slope of the Northwest Ridge directly opposite the ridgeline from Pit 4 (at elevations below the Pit4 lake elevation) is consistent with this hypothesis.</p> <p>An evaluation of water quality information yields conflicting indications regarding the potential for northward groundwater flow from the MA toward the Northwest Ridge and Sand Creek drainage. Monitoring well GW-26, located along the northern segment of the Northwest Ridge, has been sampled semi-annually over 16 years. Manganese concentrations have occasionally exceeded the SMCL of 0.05 mg/L (maximum concentration is 0.26 mg/L). Additionally, total uranium concentrations occasionally exceeded the MTCA, but are within the same order or magnitude. The pH has often been below the MCL range of 6.5 to 8.5 (the lowest was 5.83).</p>	<p>Determine whether affected groundwater has migrated or has the potential to migrate past Northwest Ridge toward the Sand Creek drainage (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).</p>	<p>Lateral: The portion of the PIA. extending from the MA boundary past the Northwest Ridge to the Sand Creek drainage.</p> <p>Vertical: From ground surface to the deepest affected groundwater flow path.</p> <p>Temporal: Current conditions</p>	<p>1) Groundwater flow directions and pathways</p>	<p>Groundwater elevations, MWNW-01, MWNW-02, MWNW-03, MWNW-04, and MWNW-05, 4 seasons</p>	<p>Groundwater elevations</p>	<p>This decision requires a determination of whether the Northwest Ridge is a groundwater divide, and, if so, whether there is the possibility that localized groundwater migration has occurred from the MA to the Sand Creek drainage even in the presence of a groundwater divide. Evaluation of the presence or absence of a groundwater divide coincident with the ridgeline will be accomplished by measuring hydraulic heads in new piezometers placed along the ridgeline. If the heads along the ridgeline are higher than heads in the MA, then it will be concluded the ridgeline is a groundwater divide. If the heads along the ridgeline are lower than heads in the MA, it will be concluded the ridgeline is not a groundwater divide. It is possible that some portions of the ridgeline will be a divide, while others are not.</p>
					<p>2) Maximum constituent concentrations for all PCOCs in groundwater downgradient of MA boundary and in seep water on the north slope of the Northwest Ridge</p>	<p>Water table GW, MWNW-07, Up to 3 events Surface water, SWNW-01, SWNW-02, and SWNW-03, up to 3 events Sediment, SDNW-01, SDNW-02, and SDNW-03, up to 2 events</p>	<p>Metals, radionuclides, inorganics, other parameters</p>	<p>An evaluation of groundwater quality north of the ridgeline for the purpose of determining whether the Sand Creek drainage has been affected by the MA would initially only be conducted for those areas determined to be downgradient of the MA. This will be determined based on the hydraulic head measurements discussed above and is expected only for the portion of the Northwest Ridge overlain by the area of exposed mineralized rock (i.e., in the vicinity of well MWNW-07). However, if it is determined that other segments of the ridgeline are not a groundwater divide, then other groundwater sampling and analysis in the Sand Creek drainage would be warranted.</p> <p>Regardless of the results of the hydraulic head assessment, surface water and sediment samples will be collected and analyzed from the seeps observed on the north slope of the Northwest Ridge to evaluate whether the presence of those seeps is indicative of flow from the Pit 4 lake toward the Sand Creek drainage. If the seep water contains constituents at concentrations in excess of background concentrations, it will be deemed further evidence of the potential for northward migration of groundwater. Additional investigations would then be warranted, possibly including isotopic or other tracer studies to assess whether Pit 4 lake water and the seep water are related.</p>

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Northwest Ridge (cont.)		On the other hand, previous USGS analyses of seep water samples for locations on the northern slope of the Northwest Ridge, located at elevations where potential MA impacts might be expected, suggest that this water has not been affected by the MA.			3) Background concentrations for PCOCs in bedrock groundwater	See background sampling program	See background sampling program	A comparison of PCOC concentrations in the Northwest Ridge area to background concentrations for the purpose of determining whether groundwater has been affected by the MA would be necessary for those portions of the Northwest Ridge determined to be downgradient of the MA, or suspected of being affected by localized flowpaths from the MA. Those portions of the Northwest Ridge determined to be upgradient of and unaffected by the MA would potentially be suitable locations for measurement of background groundwater quality.
			Determine whether contaminated groundwater has migrated past the Northwest Ridge, and conduct baseline risk assessments (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Northwest Ridge, extending from the MA boundary to just beyond the topographic ridge. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum PCOC constituent concentrations in groundwater downgradient of the MA boundary (locations as above that indicate mine effects)	Water table GW, MWNW-07, 3 events	Metals, radionuclides, inorganics, other parameters	This decision is relevant only if it is determined that affected groundwater has migrated or has the potential to migrate from the MA past the Northwest Ridge toward the Sand Creek drainage. This will be determined based on the hydraulic head assessment, the results of seep sampling, and additional investigations, as necessary.
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur if it is determined that affected groundwater has migrated past the Northwest Ridge to the Sand Creek drainage.
			Determine whether contaminated groundwater may migrate past the Northwest Ridge in the future (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Northwest Ridge, extending from the MA boundary to the topographic ridge. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Future conditions to 1,000 years from the present.	Maximum future constituent concentrations in groundwater downgradient of the MA boundary:			This decision is relevant only if it is determined that contaminated groundwater has not migrated past the Northwest Ridge, but may in the future. This will be determined based on the hydraulic head assessment, the results of seep sampling, and additional Phase 2 investigations, if necessary.
					1) Information to support flow and fate and transport modeling	None in Phase 1A	None	The decision regarding whether predictive modeling will be necessary will depend on whether it is determined that affected groundwater has the potential to migrate past the Northwest Ridge in Phase 1A. No data collection to support predictive modeling is proposed in Phase 1A.
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur if it is determined that affected groundwater has migrated past the Northwest Ridge to the Sand Creek drainage.
Far West Drainage	PIA	The Far West Drainage is the topographic surface drainage that exists immediately west of the southern portion of the MA. Surface water runoff and groundwater enters the Far West Drainage from the extreme western portion of the MA between the Northern and the Southern Topsoil Piles. This portion of the MA includes the Vehicle Shop and the Mine Offices Area. Based on detailed aerial photograph evaluation, the Vehicle Shop and the open areas to the north and east were apparently used for vehicle maintenance and service, and for storage and dispensing of fuel (Peters, 1999).	Determine whether exposure pathways associated with surface water, sediment, or groundwater are potentially complete and significant for humans or the environment, and/or whether ARARs apply (see PIA Surface Water/Sediment and Groundwater Decision Flow Charts).	Lateral: The portion of the PIA within the Far West Drainage, extending southward to Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current and future conditions	Human health and ecological CSMs	None	None	The CSMs depict the complete and significant exposure pathways for humans and the environment. The CSMs indicate that exposure pathways associated with surface water, sediment, and groundwater are potentially complete and significant.
					Preliminary ARARS	None	None	Preliminary ARARS exist for PIA groundwater and surface water.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Far West Drainage (cont.)		Vehicle washing also appears to have been performed in this area. Based on the appearance of soil stains in the aerial photographs, numerous spills of vehicle-related organic constituents, possibly including fuels, waste oil, solvents, and other petroleum products may have occurred in this area. A smaller degree of staining was also observed in the Mine Offices area.	Determine whether affected surface water, sediment, or groundwater has migrated past the MA boundary toward the Far West Drainage (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Far West Drainage, extending southward to Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum constituent concentrations for all PCOCs in surface water, sediment, and groundwater in the Far West Drainage downgradient of potential contaminant sources (i.e., Vehicle Shop and Mine Offices Area and the waste rock pile).	<u>West of Vehicle Shop and Mine Offices Area:</u> Water table GW, MFWF-03, MFWF-04, MFWF-05, Up to 3 events <u>Along Drainage Southwest of Vehicle Shop and Mine Offices Area:</u> Surface water, SWFW-01, Up to 3 events Sediment, SDFW-01, Up to 2 events Water table GW , MFWF-01, Up to 3 events Deep bedrock GW, MFWF-02, Up to 3 events	VOCs (GW only), SVOCs, metals, radionuclides, inorganics, TPH, other parameters VOCs (GW only), SVOCs, metals, radionuclides, inorganics, TPH, other parameters	This decision requires the results of chemical analyses for vehicle-related organic constituents (which do not occur naturally in this environment), and a comparison of PCOC constituent concentrations to background concentrations for naturally-occurring inorganic constituents to determine whether the MA has affected these media. A total of 3 events are planned for groundwater and surface water sampling (two in the spring and one in the fall). Less than three sampling events are necessary to resolve this decision if the data indicate that naturally-occurring inorganic PCOC concentrations exceed background levels. Maximum sediment concentrations are expected to occur during the low flow season, when the effects from evaporative deposition of salts may be at a maximum. Therefore, one sampling event for sediment is planned for the fall. Additional sediment samples will be collected as verification samples at locations where PCOC concentrations in samples from the fall event exceed background levels. Currently available information is not sufficient to indicate whether surface water, sediment, or bedrock groundwater in the Far West Drainage have been affected by the MA. <u>West of Vehicle Shop and Mine Offices Area and Waste Rock Pile:</u> Maximum constituent concentrations in groundwater within the Far West Drainage are expected to occur immediately downgradient of potential contaminant sources in the extreme western portion of the MA (i.e., the Vehicle Shop and Mine Offices Area and the waste rock pile). Therefore, wells (MFWF-03, MFWF-04, MFWF-05) are proposed along potential groundwater flow paths to detect constituents, if present. <u>Along Drainage Southwest of Vehicle Shop and Mine Offices Area:</u> Affected surface water and sediment may be present within the topographic drainage bottom downstream of the Vehicle Shop and Mine Offices Area and the waste rock pile. Surface water and sediment data (SWFW-01 and SDFW-01) are expected to resolve whether surface water or sediment have been affected by the MA. Also, deeper bedrock groundwater flow paths may discharge along the drainage with distance from the potential sources or may extend down the drainage. Water table and deeper bedrock groundwater data (MFWF-01 and MFWF-02) are expected to resolve whether groundwater has been affected by the MA.
		The Far West Drainage also contains a remnant pile of waste rock located immediately west of the Vehicle Shop area.				Groundwater elevations, all existing and new wells in Far West Drainage, 4 seasons	Groundwater elevations	Bedrock horizontal groundwater flow is expected to be from the extreme western portion of the southern MA toward the Far West Drainage. Saturated alluvium is expected to occur in the bottom of the drainage. Groundwater flow direction in the alluvium is expected to be southward along the alignment of the Far West Drainage. Groundwater data from the alluvial and bedrock wells in the Far West Drainage are anticipated to confirm the expected gradients.
		The Far West Drainage receives direct runoff from the western portion of the Vehicle Shop and the Mine Offices Area and from the waste rock pile. Bedrock groundwater from the western portion of the Vehicle Shop and Mine Offices Area and from the waste rock pile area may also flow toward the Far West Drainage.				See background sampling program	See background sampling program	This decision involves comparison of concentrations for naturally-occurring inorganic constituents to background concentrations to determine the presence of mine effects. The background sampling program is described separately. For vehicle-related organic constituents (which do not occur naturally in this environment), the presence of the constituents in water or sediment will be sufficient to determine the presence of mine effects.
		The quality of surface water, and sediment cannot be assessed in the Far West Drainage area because no analytical data are available.						
		Groundwater in the eastern portion of the Far Western Drainage may be affected by the MA. Two groundwater-sampling locations (GW-23 and GW-24) are available to assess the quality of groundwater in this area. Both wells have been sampled semi-annually for water quality for 16 and 14 years, respectively. GW-24 is located on the western boundary of the MA, near the Mine Shops; and GW-23 is located west of the MA, southwest of GW -24. GW -24 consistently has total uranium concentrations above the MTCA of 20 µg/L (maximum concentration is 380 µg/L).	Determine whether contaminated surface water, sediment, or groundwater has migrated beyond the MA boundaries to the Far West Drainage, and conduct baseline risk assessments (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Far West Drainage, extending southward to Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current conditions	1) Maximum or 95% UCL PCOC constituent concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundary (locations as above that indicate mine effects)	Same samples as above with the exception 3 data collection events (up to 2 events for sediments) are required to support the baseline risk assessments	VOCs (GW only), SVOCs, metals, radionuclides, inorganics, TPH, other parameters	This decision involves the comparison of maximum or 95% UCL PCOC constituent concentrations to preliminary ARARs and assessment of whether the maximum concentrations pose an unacceptable risk. The constituent concentration information obtained in the previous decision is also used for this decision, but may be supplemented by data for additional seasons. Currently available information is not sufficient to determine whether the Far West Drainage has been affected or contaminated by the MA.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Far West Drainage (cont.)		GW-23 occasionally (3 times) has exhibited concentrations above the MTCA (maximum concentration is 164 µg/L). Both locations have a groundwater pH that is often slightly acidic (i.e., less than the SMCL of 6.5 – 8.5; the lowest pH was 6.02, in a sample collected from GW-23). Manganese is consistently above the SMCL of 0.05 mg/L at both locations. The maximum manganese concentration for GW-24 is 1.25 mg/L, and the maximum manganese concentration for GW-23 is 3.9 mg/L. Iron is often present at concentrations above the SMCL at both locations, occasionally at concentrations of one order of magnitude above the SMCL.			2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur if mine effects are detected in the Far West Drainage.
					3) Surface water flow rate	Temporary flume, SWFW-01, 4 seasons	Surface water flow rate	Estimation of mass loading of contaminants via streams is necessary for the ecological risk assessment. Mass loading is estimated using contaminant concentrations and stream flow rates.
			Determine whether contaminated surface water, sediment, or groundwater may migrate beyond the MA boundary to the Far West Drainage in the future (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Far West Drainage, extending southeastward to Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Future conditions to 1,000 years from the present	Maximum future constituent concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundary:	None in Phase 1A	None	This decision is relevant only if it is determined that contaminated surface water, sediment, or groundwater have not migrated to the Far West Drainage, but may in the future. Currently available information is not sufficient to determine whether contamination has migrated to the Far West Drainage. Thus it is not known at this time whether this decision is relevant for the Far West Drainage or not.
					1) Information to support flow and fate and transport modeling			The decision regarding whether predictive modeling will be necessary will depend on whether contamination is detected in the Far West Drainage in Phase 1A. Thus no data collection to support predictive modeling is proposed in Phase 1A.
South-western Drainage	PIA	The Southwestern Drainage is the topographic surface drainage that exists southwest of the southern portion of the MA. Surface water runoff and groundwater enters the Southwestern Drainage from the southwestern portion of the MA between the Southern Topsoil Pile and the Western Drainage.	Determine whether exposure pathways associated with surface water, sediment, or groundwater are potentially complete and significant for humans or the environment, and/or whether ARARs apply (see PIA Surface Water/Sediment and Groundwater Decision Flow Charts).	Lateral: The portion of the PIA within the Southwestern Drainage, extending southward to Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path. Temporal: Current and future conditions	Human health and ecological CSMs	None	None	The CSMs depict the complete and significant exposure pathways for humans and the environment. The CSMs indicate that exposure pathways associated with surface water, sediment, and groundwater are potentially complete and significant.
					Preliminary ARARS	None	None	Preliminary ARARS exist for PIA groundwater and surface water.
		Vehicle parking and maintenance areas may have been present in the MA potentially upgradient of the Southwestern Drainage. Soil staining has been identified based on detailed evaluation of aerial photographs (Peters, 1999).	Determine whether affected groundwater is present in the Southwestern Drainage (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	Lateral: The portion of the PIA within the Southwestern Drainage, extending southward to Blue Creek. Vertical: From ground surface to the deepest affected groundwater flow path.	1) Maximum constituent concentrations for all PCOCs in surface water, sediment, and groundwater in the Southwestern Drainage downgradient of the MA	Surface Water, SWSW-02, Up to 3 events Sediment, SDSW-02, Up to 2 events Alluvial GW, MWSW-02, Up to 3 events Bedrock GW, MWSW-01, Up to 3 events	Metals, radionuclides, inorganics, TPH, other parameters	This decision requires the results of chemical analyses for vehicle-related organic constituents (which do not occur naturally in this environment), and a comparison of PCOC constituent concentrations to background concentrations for naturally-occurring inorganic constituents to determine whether the MA has affected these media. A total of 3 events are planned for groundwater and surface water sampling (two in the spring and one in the fall). Less than three sampling events are necessary to resolve this decision if the data indicate that naturally-occurring inorganic PCOC concentrations exceed background levels. Maximum sediment concentrations are expected to occur during the low flow season, when the effects from evaporative deposition of salts may be at a maximum. Therefore, one sampling event for sediment is planned for the fall. Additional sediment samples will be collected as verification samples at locations where PCOC concentrations in samples from the fall event exceed background levels. Currently available information is not sufficient to indicate whether surface water, sediment, or groundwater in the Southwestern Drainage have been affected by the MA.
					2) Groundwater flow directions and pathways in unconsolidated material and bedrock.	Groundwater elevations, MWSW-02 and MWSW-01, 4 seasons	Groundwater elevations	Bedrock horizontal groundwater flow is expected to be from the extreme southwestern portion of the southern MA toward the Southwestern Drainage axis. Saturated alluvium is expected to occur where the drainage is well established southwest of the MA. Groundwater flow direction in the alluvium is expected to be southward along the alignment of the Southwestern Drainage. Groundwater data from the alluvial and bedrock wells in the Southwestern Drainage are anticipated to confirm the expected gradients.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
South-western Drainage (cont.)		<p>The Southwestern Drainage may receive bedrock groundwater flow from the southwestern portion of the MA, particularly the South Spoils.</p> <p>The quality of surface water and sediment in the Southwestern Drainage area cannot be assessed because no analytical data are available.</p> <p>Groundwater may be slightly affected by the MA. One groundwater sampling location, GW-28 is located west of the southern portion of the MA. GW-28 has been sampled semi-annually for water quality for 16 years.</p> <p>The total uranium concentration is occasionally elevated above the MTCA of 20 µg/L, but within the same order of magnitude. The pH was below the SMCL of 6.5 – 8.5 only once (in 1984 the pH was 4.7). Manganese is consistently above the SMCL of 0.05 mg/L (maximum is 1.1 mg/L). Iron is occasionally above the SMCL of 0.3 mg/L (once by an order of magnitude).</p>			3) Background concentrations for naturally-occurring inorganic PCOCs in surface water, sediment, and groundwater (alluvial and bedrock)	See background sampling program	See background sampling program	This decision involves comparison of concentrations for naturally-occurring inorganic constituents to background concentrations to determine the presence of mine effects. The background sampling program is described separately. For vehicle-related organic constituents, the presence of the constituents in water or sediment will be sufficient to determine the presence of mine effects.
			Determine whether contaminated groundwater is present in the Southwestern Drainage, and conduct baseline risk assessments (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	<p>Lateral: The portion of the PIA within the Southwestern Drainage, extending southward to Blue Creek.</p> <p>Vertical: From ground surface to the deepest affected groundwater flow path.</p> <p>Temporal: Current conditions</p>	1) Maximum PCOC constituent concentrations in surface water, sediment, and groundwater downgradient of the MA boundary (locations as above that indicate mine effects)	Same samples as above with the exception that 3 sampling events (up to 2 events for sediments) are required to support the baseline risk assessments	Metals, radionuclides, inorganics, TPH, other parameters	This decision involves the comparison of PCOC constituent concentrations to preliminary ARARs and assessment of whether the maximum concentrations pose an unacceptable risk. The constituent concentration information obtained in the previous decision is also used for this decision, but may be supplemented by data for additional seasons. Currently available information is not sufficient to determine whether the Southwestern Drainage has been affected or contaminated by the MA.
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur if mine effects are detected in the Southwestern Drainage.
					3) Surface water flow rate	Temporary flume, SWSW-01, 4 seasons	Surface water flow rate	Estimation of mass loading of contaminants via streams is necessary for the ecological risk assessment. Mass loading is estimated using contaminant concentrations and stream flow rates.
			Determine whether contaminated groundwater may migrate to the Southwestern Drainage in the future (see PIA Surface Water/Sediment and Groundwater Decision Flow charts).	<p>Lateral: The portion of the PIA within the Southwestern Drainage, extending southeastward to Blue Creek.</p> <p>Vertical: From ground surface to the deepest affected groundwater flow path.</p> <p>Temporal: Future conditions to 1,000 years from the present</p>	Maximum future constituent concentrations in surface water, sediment, and groundwater at or downgradient of the MA boundary:			This decision is relevant only if it is determined that contaminated groundwater has not migrated to the Southwestern Drainage, but may in the future. Currently available information is not sufficient to determine whether contamination is present in the Southwestern Drainage. Thus it is not known at this time whether this decision is relevant for the Southwestern Drainage or not.
					1) Information to support flow and fate and transport modeling	None in Phase 1A	None	The decision regarding whether predictive modeling will be necessary will depend on whether contamination is detected in the Southwestern Drainage in Phase 1A. Thus no data collection to support predictive modeling is proposed in Phase 1A.
					2) Preliminary ARARs and risk assessment results	None	None	Preliminary ARARs have been identified for the site. Baseline human health and ecological risk assessments will be performed to determine whether unacceptable risks may occur if mine effects are detected in the Southwestern Drainage.
Blue Creek	PIA	<p>Blue Creek is a perennial stream that receives surface water drainage from the Midnite Mine area. Blue Creek flows into the Spokane River Arm of Roosevelt Reservoir approximately 3.4 miles below its confluence with the Eastern Drainage.</p> <p>Surface water and sediment from drainages downgradient of the MA discharge into Blue Creek, which may include water and sediment potentially impacted by the MA.</p>	Determine whether surface water or sediment are complete and significant exposure pathways for humans or the environment, and/or whether ARARs apply (see Decision flowcharts)	<p>Lateral: The Blue Creek active channel corridor downstream of the confluence with the Eastern Drainage extending southwestward downstream to the Spokane Arm of Roosevelt Reservoir.</p> <p>Vertical: Surface water and alluvial material within the Blue Creek active stream channel.</p> <p>Temporal: Current conditions including season variation in surface water.</p>	Human health and ecological conceptual site models (CSMs)	None	None	The CSMs depict the complete and significant exposure pathways for humans and the environment in the Blue Creek PIA. The CSMs indicate that exposure pathways associated with surface water and sediment are potentially complete and significant.
					Preliminary ARARS	None	None	Preliminary ARARS exist for PIA groundwater and surface water.

SECTION A

Project Management

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Blue Creek (cont.)		Potentially impacted water includes water bypassing mine water collection systems, seeps/springs from groundwater flow pathways, surface water runoff and sediment erosion from disturbed areas on the perimeter of the MA, water from an NPDES discharge outfall, sediment deposited in the Western Drainage during early mining activities, runoff and sediment from haul roads covered with mine waste rock, and runoff and sediment from soils contaminated with windblown sediments.	Determine whether affected surface water or sediment has migrated to Blue Creek.	Lateral: The Blue Creek active channel corridor downstream of the drainage immediately east of the Eastern Drainage extending southwestward downstream to the Spokane Arm of Roosevelt Reservoir. Vertical: Surface water and sediment within the Blue Creek active stream channel. Temporal: Current conditions.	(1) Maximum constituent concentrations for all PCOCs in: <ul style="list-style-type: none">Surface water and sediment in the Blue Creek channel directly below the confluence with the Eastern Drainage.Surface water and sediment, from a location directly upstream of the confluence with Eastern Drainage.Background concentrations of naturally occurring inorganic PCOCs in surface water and sediment including a sample of Blue Creek above the drainage immediately east of the ED (see Background Sampling Program).	Surface water, BC09SW, Up to 3 events Streamflow rate, 4 seasons Sediment, BC09SD, Up to 2 events Surface water, BC10SW, Up to 3 events Streamflow rate, 4 seasons Sediment, BC10SD, Up to 2 events	Metals, radionuclides, inorganics, discharge	This decision requires a comparison of maximum constituent concentrations along Blue Creek to upstream concentrations and background concentrations to determine whether surface water and sediment in Blue Creek have been affected. Maximum constituent concentrations in surface water and sediment within Blue Creek are expected to occur along or near the drainage axis or active channel, and may vary with season. Thus, to evaluate maximum surface water and sediment concentrations as they may be affected by the MA, constituent concentration data are required for high flow and low flow in the vicinity of the active Blue Creek channel immediately upgradient and downgradient of the confluence with Eastern Drainage. A total of 3 events are planned for groundwater and surface water sampling (two in the spring and one in the fall). Less than three sampling events are necessary to resolve this decision if the data indicate that naturally-occurring inorganic PCOC concentrations exceed background levels. The sampling events will be scheduled so that the effects of discharge from the WTP on water quality in the drainage can be evaluated. The fall sampling event and the second spring event will coincide with WTP discharge. The first spring event will occur during a period of zero WTP discharge. Maximum sediment concentrations are expected to occur during the low flow season, when the effects from evaporative deposition of salts may be at a maximum. Therefore, one sampling event for sediment is planned for the fall. Additional sediment samples will be collected as verification samples at locations where PCOC concentrations in samples from the fall event exceed background levels. Currently available information indicates that surface water and sediment may have been affected. To assess the degree of seasonal change in surface water constituent concentrations as Blue Creek flows by the confluence, samples will be collected in Blue Creek just below the confluence of the ED (BC09SW) during each of the sampling events and compared with samples collected above the confluence with the drainage immediately east of the ED (BC10SW).
		Several inorganic constituents were consistently found in surface water samples collected along Blue Creek at concentrations exceeding their SMCLs or MTCA, including aluminum, iron, manganese, and total uranium. The maximum aluminum (3.04 mg/L) and iron (2.7 mg/L), concentrations were found in a sample collected approximately 1,200 feet upstream of the confluence of the Eastern Drainage and Blue Creek. Though manganese and total uranium were consistently detected at elevated concentrations, their maximum concentrations (0.735 mg/L [SMCL is 0.05 mg/L] and 0.047 mg/L [MTCA is 0.02 mg/L], respectively) were found in a sample collected at the confluence.			(2) Maximum constituent concentrations for all PCOCs in: <ul style="list-style-type: none">Surface water and sediment in the Blue Creek channel approximately one mile downstream of the Eastern Drainage confluence.Background concentrations of naturally occurring inorganic PCOCs in surface water and sediment including a sample of Blue Creek upstream of the drainage immediately east of the ED (see Background Sampling Program).	Surface water, BC05SW, Up to 3 events Streamflow rate, BC05SW, 4 seasons Sediment, BC05SD, Up to 2 events	Metals, radionuclides, inorganics, discharge	Changes in surface water and sediment constituent concentrations may occur with increasing distance from the Eastern Drainage confluence as a result of dilution and contributions of tributaries. However, a preliminary examination of existing data indicate that constituent concentrations may actually increase downstream, thus indicating other downstream sources of PCOCs. Therefore, surface water (BC05SW) and sediment (BC05SD) constituent concentration data are required further down the drainage for use in evaluating the change potentially caused by drainage from the MA or other downstream sources. Large sets of data have already been collected to characterize surface water and sediment constituent concentrations. It is assumed that these data will be largely sufficient for making the necessary decision after comparison to the background data to be collected in Phase I. Nonetheless, additional sampling is needed at selected locations along Blue Creek and tributaries in Phase I to further evaluate the PCOC concentrations previously reported.
		Radium 228 was detected in a surface water sample collected approximately 1,200 feet upstream of the confluence with the Eastern Drainage (at 2.5 pCi/L, the human health drinking water PRG is 0.19 pCi/L). Samples collected further downstream of the confluence contained elevated radium 228 (maximum concentration is 3.0 pCi/L in a sample collected approximately 2.3 miles downstream from the confluence). U ₂₃₄ and U ₂₃₈ were detected in all the samples collected at or downstream of the confluence. Concentrations range from 1.6 to 11.6 pCi/L, with the maximum concentration found immediately downstream of the confluence (the human health drinking water PRG is 1.1 pCi/L for both constitutes).			(3) Maximum constituent concentrations for all PCOCs in: <ul style="list-style-type: none">Surface water and sediment in the Blue Creek channel directly below the confluence with Oyachen Creek.Surface water and sediment, from a location in the Oyachen Creek channel directly upstream of the confluence with Blue Creek.	Surface water, TR06SW, Up to 3 events Streamflow rate, 4 seasons Sediment, TR06SD, Up to 2 events Surface water, BC04SW, Up to 3 events Streamflow rate, BC04SW, 4 seasons Sediment, BC04SD, Up to 2 events	Metals, radionuclides, inorganics	The Sherwood Mine, a sizable a uranium mine with tailing and milling facilities, is located near the southern drainage divide of the Oyachen Creek watershed. Previous investigators in the area have postulated that the Sherwood Mine has the potential to affect waters in the Oyachen Creek. Although the mapped topography (USGS 1985) indicates that surface water runoff from the Sherwood Mine area does not flow to Oyachen Creek, it is necessary to know if Oyachen Creek is a contributor of affected water and sediment to Blue Creek. To do this, analysis results for samples collected in Oyachen Creek (TR06SW and TR06SD) will be compared to samples collected below the confluence with Blue Creek (BC04SW and BC04SD), samples collected in the tributary to the north and downstream of Oyachen Creek (TR05SD and TR05SW) and samples collected above the confluence (BC05SW and BC05SD). Samples collected in the tributary further downstream of the Oyachen Creek/Blue Creek confluence and south of Blue Creek (TR04SD and TR04SW) will also be compared to the other samples on Blue Creek and its tributaries.

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
		Naturally high inorganic constituent concentrations may occur in Blue Creek sediments due to water and sediment flowing from natural sources of metals and radioactive materials in tributaries. Existing data show that some inorganic constituent concentrations appear to increase with distance from the confluence. Also, previous reports for the Blue Creek drainage state that Oyachen Creek, a major tributary to Blue Creek with its confluence located about 1.5 miles downstream of the Eastern Drainage confluence, is potentially affected by uranium mining operations located upgradient of that watershed. Therefore, it is necessary to separate the affects of Eastern Drainage discharges from naturally occurring and other sources of elevated constituent levels.			(4) Maximum constituent concentrations for all PCOCs in surface water and sediment in tributaries known to possibly contribute media with high constituent concentrations	Surface water, TR05SW, Up to 3 events Streamflow rate, TR05SW, 4 seasons Sediment, TR05SD, Up to 2 events Surface water, TR04SW, Up to 3 events Streamflow rate, TR04SW, 4 seasons Sediment, TR04SD, Up to 2 events	Metals, radionuclides, inorganics	Data collected in tributaries to Blue Creek downstream of the Oyachen Creek confluence indicate that surface water and sediment from these tributaries may contain chemical constituents at naturally high concentrations that may contribute PCOCs to Blue Creek. Thus, it is necessary to collect surface water and sediment samples in tributaries to downstream reaches of Blue Creek.
		Sediment samples collected approximately 1,200 to 1,800 feet upstream of the confluence of the Eastern Drainage and Blue Creek do not contain chemical constituents at concentrations exceeding their preliminary ecological screening values or human health PRGs for soil. Surface sediment samples collected approximately 900 feet upstream of this confluence contain cadmium and nickel at concentrations slightly above the preliminary ecological screening values. Manganese is present at a concentration of 7,480 mg/kg (the Region IX PRG is 3,100 mg/kg), and U ₂₃₅ is present at concentrations slightly above the human health PRG for soil (maximum concentration is 0.27 pCi/g, the PRG is 0.16 pCi/g). Immediately below the confluence of the Eastern Drainage and Blue Creek, nickel is present in sediment samples at concentrations above the preliminary ecological screening values. Manganese is present at concentrations exceeding the Region IX PRGs (manganese has a maximum concentration of 63,300 mg/kg, the Region IX PRG is 3,100 mg/kg). Several radioactive constituents are present in sediment samples collected immediately below this confluence, including U ₂₃₅ (maximum is 1.2 pCi/g) and U ₂₃₈ (maximum is 30 pCi/g) at concentrations slightly above their human health PRGs for soil of 0.16, and 21 pCi/g, respectively.			(5) Maximum constituent concentrations for all PCOCs in surface water and sediment in the Blue Creek channel at locations near the beaches at Roosevelt Reservoir to confirm previous data indicating apparently high natural constituent concentrations.	Surface water BC01SW, Up to 3 events Streamflow rate, BC01SW, 4 seasons Sediment, BC01SD, Up to 2 events Surface water SWBC-01, Up to 3 events Streamflow rate, SWBC-01, 4 seasons Sediment, BC01SD, Up to 2 events Sediment, SDBC-02, Up to 2 events	Metals, radionuclides, inorganics	Samples collected near the point of Blue Creek inflow to Roosevelt Reservoir will be used to evaluate constituent concentration data previously collected there. One of these sample locations (BC01SW/BC01SD) will be collected in the active channel of Blue Creek just above the confluence of the drainage from the Sherwood Mine area. Another surface water sample and sediment sample (SDBC-01/SWBC-01) will be collected in the tributary from the Sherwood Mine just above the confluence from Blue Creek. Another sediment sample (SDBC-02) will be collected in the dry sand beach area at the mouth of Blue Creek at Roosevelt Reservoir. These data will be evaluated with consideration of all contributing factors affecting constituent concentrations of water and sediment in Blue Creek with the purpose of characterizing possible effects of sources in the MA on the lower stream reach.

SECTION A

Project Management

Table A.7.2-2
DATA QUALITY OBJECTIVES FOR STREAM SURFACE WATER, STREAM SEDIMENT, AND GROUNDWATER PATHWAYS IN THE PIA

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups ²	Rationale for the Sampling Design
Blue Creek (cont.)		<p>Sediment samples collected approximately 600 to 2,400 feet downstream of the confluence of the ED and Blue Creek contain manganese and nickel at concentrations above the preliminary ecological screening values. Manganese concentrations vary from 314 to 2,010 mg/kg and the maximum nickel concentration is 30 mg/kg. U₂₃₅ concentrations vary from non-detected to 0.24 pCi/g.</p> <p>However, in sediment samples collected in Blue Creek further downstream of the ED with Blue Creek, several inorganic constituents are present at concentrations above their preliminary ecological screening values. Constituents include aluminum (maximum is 21,600 mg/kg), arsenic (maximum is 17.5 mg/kg), nickel (maximum is 57.5 mg/kg), zinc (maximum is 128 mg/kg), and U₂₃₅ (maximum is 0.679 pCi/g).</p>	<p>Determine whether contaminated surface water or sediment may affect Blue Creek in the future.</p>	<p>Lateral: The Blue Creek active channel corridor downstream of the drainage immediately east of the Eastern Drainage extending southwestward downstream to the Spokane Arm of Roosevelt Reservoir.</p> <p>Vertical: Surface water and sediment within the Blue Creek active stream channel.</p> <p>Temporal: Future conditions to 1,000 years from present.</p>	<p>(1) Maximum future PCOC constituent concentrations in surface water and sediment along Blue Creek.</p> <p>(2) Information to support flow and fate and transport modeling.</p>	<p>None</p> <p>None</p>	<p>None</p> <p>None</p>	<p>This decision is relevant only if it is determined that contaminated surface water or sediment have not affected Blue Creek, but may in the future. Currently available information appears to indicate that surface water and sediment in the upper part of Blue Creek have been affected by the MA. However, it is unclear whether Blue Creek has been contaminated. The objective of the Phase 1A sampling and background sampling data is to determine whether Blue Creek has been contaminated by the MA. Therefore, the decision statement regarding the potential for future contamination of Blue Creek may not be relevant. Thus no data collection is required in Phase 1A.</p>

- Notes:
- 1) Affected media are media that have been impacted by Midnite Mine mining activities such that PCOC concentrations exceed background levels. Contaminated media are affected media that have been impacted by Midnite Mine mining activities such that PCOC concentrations exceed preliminary ARARs and/or pose an unacceptable risk to human health or the environment.
- 2) Specific analytes are listed in Tables ____ through ____.

MA

- Mined Area

PIA

- Potentially Impacted Area

VOCs

- Volatile Organic Compounds

SVOCs

- Semi-Volatile Organic Compounds

pCi/L

- picoCuries per liter

MCL

- Maximum Contaminant Level

CSMs

- Conceptual Site Models

ARARs

- Applicable or Relevant and Appropriate Requirements

mg/kg

- milligrams per kilogram

SMCL

- Secondary MCL

GW

- Groundwater

TPH

- Total Petroleum Hydrocarbons

TDS

- Total Dissolved Solids

SECTION A

Project Management

Table A.7.2-3
DATA QUALITY OBJECTIVES FOR SURFACE WATER, SEDIMENT, AND GROUNDWATER BACKGROUND

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups	Rationale
Background	Areas near the mine that are hydrogeologically similar to the site and are unaffected by mine operations.	Many of the chemical constituents present in environmental media in the mined area (MA) or in the potentially impacted area (PIA) are naturally occurring. Unmined uranium ore in the MA and at other mineralized areas (mining prospects) in the vicinity provide natural sources of inorganic constituents such as metals and radionuclides. These constituents may be present in the MA or in the PIA at concentrations that exceed ARARs but do not exceed natural (background) levels.	Determine whether chemical constituent concentrations in surface water and sediment in the PIA exceed background concentrations.	Lateral: Surface water drainages that carry streamflow from the Spokane Mountain vicinity, Sand Creek north of the site, and reaches of Blue Creek and its tributaries that are upgradient of the drainages from the MA.	Geologic information that indicates the locations of one or more nearby areas that are geologically similar to the mined area and are unaffected by mine operations.	See sampling program for surface water and sediment in the MA and the PIA.	Metals, radionuclides, inorganics, other parameters	This decision requires maximum constituent concentrations in the MA and PIA to be compared with background concentrations to assess whether surface water or stream-deposited sediments have been affected by mining. Thus, it is necessary to characterize the background range of constituent concentrations for these media.
		In areas that are upgradient of the MA, groundwater occurs in both unconsolidated materials (alluvium), and bedrock. The natural concentrations of inorganic constituents in alluvial groundwater may differ from constituent concentrations in bedrock groundwater.		Temporal: Current conditions (Surface water – 3 events; Sediment – one event)	Hydraulic head information north of MA and along the Northwest Ridge that confirms hydraulic gradients are southward, thus indicating locations that have not been affected by groundwater flow from the MA.	Surface water, 16 background sample locations, 4Q		Background concentrations also will be required for determining cleanup levels for constituents that naturally occur at concentrations above ARARs, and risk based cleanup levels.
		In the MA and in the PIA, groundwater also occurs in both unconsolidated materials and bedrock. The unconsolidated materials in the MA consist of alluvium, waste rock, protore/ore, and other fill materials. In the mined area and downgradient of the mine, groundwater in unconsolidated materials interacts with bedrock groundwater; however, the degree to which they interact is unknown.			Local topography that indicates: (1) the locations of surface drainages that carry streamflow and sediment from identified geologically similar areas; and (2) areas along likely ground-water flow paths that originate in geologically similar areas.	Sediment, 16 background sample locations (one discrete and one composite sample from each location)		Constituent concentrations in surface water may vary significantly with season. Therefore, background surface water data will be collected for four seasons.
					Maximum constituent concentrations for inorganic PCOCs in surface water and sediment in potentially impacted areas.	See sampling program for surface water and sediment in the MA and the PIA.		Maximum constituent concentrations will be determined by sampling in the MA, and areas that are downstream of the MA boundary in the PIA (see tables for PIA drainages and source areas of interest in the MA).
					Constituent concentrations for naturally-occurring inorganic PCOCs in surface water and sediment in identified background areas.	See sampling program for surface water and sediment in the MA and the PIA.	See sampling program.	The numbers of background sampling locations necessary were estimated based on a statistical power analysis assuming the data will be analyzed using a non-parametric approach. This non-parametric analysis will be performed to define the upper threshold limit values for inorganic constituents in the background data set. The power analysis indicated a minimum of 16 sample locations will be needed to perform the non-parametric analysis of the data to characterize the range of background concentrations for surface water and sediment. However, the existing data for sediment downstream of the MA are of two types: discrete samples from the expanded site investigation (E&E 1998); and composite samples collected by Shepherd Miller on behalf of DMC (SMI 1999). Thus, to conduct a statistically appropriate comparison, a minimum of 16 background sediment samples for each samples type (discrete and composite) are needed for comparison to the downstream samples. Therefore, 32 sediment samples (16 discrete and 16 composite) will be collected for background characterization from 16 sediment sample locations. The surface water and sediment samples will be collected from the same locations.
						Surface water, 16 background sample locations, 4Q	Metals, radionuclides, inorganics, other parameters	Sample location SW/SDBK-01 is located in a potentially mineralized area west of the Midnite Mine. Location SWBK-02 will be sampled to confirm the results from the USGS Blue Creek background surface water sample in which elevated concentrations of inorganic chemicals were observed. SDBK-02 is a sediment sampling point colocated with SWBK-02. Locations SW/SDBK-03 through SW/SDBK-05 will be sampled to characterize background surface water and sediment concentrations in the potentially mineralized area on the southeast side of Spokane Mountain.
						Sediment, 16 background sample locations (one discrete and one composite sample from each location)		Locations SW/SDBK-06, SW/SDBK-07 through SW/SDBK-09, SW/SDBK-10 and SW/SDBK-11 will be sampled to characterize background surface water and sediment concentrations in the potentially mineralized areas on the west, northeast, and north sides of Spokane Mountain, respectively.
								Location SW/SDBK-12 will be sampled to confirm the results from the USGS background surface water sample collected from Sand Creek in which elevated concentrations of inorganic chemicals were observed. SDBK-12 is a sediment sampling point colocated with SWBK-12. Location SW/SDBK-13 will be sampled upstream of the USGS sample location in Sand Creek and downstream of the potentially mineralized Deer Mountain area. Location SW/SDBK-14 will be sampled to characterize a tributary of Sand Creek where NURE sediment sample results indicate elevated concentrations of inorganic chemicals. Locations SW/SDBK-15 and SW/SDBK-16 will be sampled to characterize background surface water and sediments downstream of the potentially mineralized area at Deer Mountain.

SECTION A

Project Management

Table A.7.2-3
DATA QUALITY OBJECTIVES FOR SURFACE WATER, SEDIMENT, AND GROUNDWATER BACKGROUND

Source or Area of Interest	Location	Problem Statement	Decision Statement	Study Area Boundary	Inputs to the Decision	Type, Locations, and Number of Samples	Analyte Groups	Rationale
			Determine whether chemical constituent concentrations in groundwater in unconsolidated materials in the MA and the PIA exceed background concentrations.	Lateral: The Spokane Mountain vicinity and areas downgradient of Spokane Mountain that are not located downgradient of the MA. Vertical: Alluvial groundwater Temporal: Current conditions (3 events)	Maximum constituent concentrations for inorganic PCOCs in seep water and groundwater in potentially impacted areas.	See sampling program for groundwater and seeps in the MA and the PIA. Background alluvial groundwater, 10 wells, 3 events	See sampling program. Metals, radionuclides, inorganics, other parameters	<p>This decision requires a comparison of maximum constituent concentrations to background concentrations to assess whether groundwater in the PIA has been affected by mining. Thus, it is necessary to characterize the background range of constituent concentrations for groundwater.</p> <p>Background concentrations also will be required for determining cleanup levels for constituents that naturally occur at concentrations above ARARs and risk cleanup levels.</p> <p>Constituent concentrations in groundwater may vary significantly with season. Therefore, background constituent concentration data will be collected for four seasons.</p> <p>The natural levels of constituents in alluvial groundwater may differ from the levels in bedrock groundwater. Therefore, it is necessary to collect background groundwater quality data for both hydrogeologic units. These data can then be evaluated to assess whether differences in water quality in the two units are statistically significant.</p> <p>The numbers of background groundwater locations necessary were estimated based on a statistical power analysis assuming the data will be analyzed using a non-parametric approach. It was assumed that background groundwater quality in the unconsolidated materials is not significantly different from the groundwater quality in the bedrock. After data are collected, this assumption will be tested by comparing the two data sets to evaluate whether additional wells may be needed. The power analysis indicated a minimum of 16 sample locations will be needed to characterize the range of background concentrations for groundwater. A total of 20 background well locations were selected because there is uncertainty regarding groundwater flow gradients along the northwest and northern boundaries of the mine due to the hydraulic influence of Pit 4. Although all of the proposed well locations are expected to be hydraulically upgradient of the MA, potentiometric surface data collected from the new wells may indicate that some of the proposed background wells are potentially downgradient of the MA. Therefore, 4 additional background well locations were selected to help ensure that sufficient background groundwater data is collected.</p> <p>Wells MWBB-01, MWBB-02, and MWBB-05 will sample groundwater representative of background conditions in the uppermost and deeper water-bearing zones downgradient of the Spokane Mountain uranium deposit.</p> <p>Wells MWBB-03 and MWBB-04 will sample groundwater within the Spokane Mountain uranium deposit. Wells MWNW-01 through MWNW-04 and MWNW-06 will be used to assess whether the hydraulic gradient from the Northwest Ridge is toward the MA. Wells MWBA-01 through MWBA-03 will sample alluvial groundwater along tributaries of Blue Creek to the east of the MA. Wells MWBA-04 and MWBA-06 will sample alluvial groundwater downgradient of Spokane Mountain along a tributary of Blue Creek. Well MWBA-05 will sample alluvial groundwater along tributary of Sand Creek where uranium concentrations in sediments appear to be elevated. Wells MWBA-07 and MWBA-09 will sample alluvial groundwater along tributaries of Sand Creek downgradient of Spokane Mountain where uranium concentrations in sediments appear to be elevated. Wells MWBA-08 and MWBA-10 will sample alluvial groundwater along Sand Creek.</p> <p>Maximum constituent concentrations will be determined during sampling in the MA, and areas that are downgradient of potential sources of groundwater contamination (see tables for PIA drainages and source areas of interest in the MA).</p>

SECTION A

Project Management

Table A.7.2-4
PRELIMINARY ARARs FOR GROUNDWATER

Chemical Constituent	Units	Maximum Contaminant Levels (MCLs)		Secondary MCLs	Maximum Groundwater Protection Values	
		(40 CFR 141) total		(40 CFR 143) total	(40 CFR 192) total	
Vinyl chloride	µg/L	2		--	--	
1,1-Dichloroethylene	µg/L	7		--	--	
1,2-Dichloroethylene (trans)	µg/L	100		--	--	
1,2-Dichloroethylene (cis)	µg/L	70		--	--	
1,1,1-Trichloroethane	µg/L	200		--	--	
Carbon tetrachloride	µg/L	5		--	--	
Benzene	µg/L	5		--	--	
1,2-Dichloroethane (EDC)	µg/L	5		--	--	
Trichloroethylene (TCE)	µg/L	5		--	--	
1,2-Dichloropropane	µg/L	5		--	--	
Bromodichloromethane	µg/L	100	****	--	--	
Toluene	µg/L	1,000		--	--	
1,1,2-Trichloroethane	µg/L	5		--	--	
Tetrachloroethylene (PCE)	µg/L	5		--	--	
Dibromochloromethane	µg/L	100	****	--	--	
Chlorobenzene	µg/L	100		--	--	
Ethylbenzene	µg/L	700		--	--	
m-Xylene	µg/L	10,000	v	--	--	
p-Xylene	µg/L	10,000	v	--	--	
o-Xylene	µg/L	10,000	v	--	--	
Styrene	µg/L	100		--	--	
Bromoform (tribromomethane)	µg/L	100	****	--	--	
Benzo[a]pyrene	µg/L	0.2		--	--	
1,2-dibromoethane	µg/L	.05				
1,2-dichlorobenzene	µg/L	600				
1,2-dibromo-3-chloropropane	µg/L	200				
1,2,4-trichlorobenzene	µg/L	70				
Aluminum	µg/L	--		50	--	
Antimony and compounds	µg/L	6		--	--	
Arsenic (cancer endpoint)	µg/L	50		--	50	
Barium and compounds	µg/L	2,000		--	1,000	
Beryllium and compounds	µg/L	4		--	--	

SECTION A

Project Management

Table A.7.2-4
PRELIMINARY ARARs FOR GROUNDWATER

Chemical Constituent	Units	Maximum Contaminant Levels (MCLs)		Secondary MCLs	Maximum Groundwater Protection Values	
		(40 CFR 141) total		(40 CFR 143) total	(40 CFR 192) total	
Cadmium and compounds	µg/L	5		--	10	
Chloride	µg/L	--		250,000	--	
Total Chromium (1/6 ratio Cr VI/Cr III)	µg/L	100		--	50	
Cyanide	µg/L	200		--	--	
Copper and compounds	µg/L	1,300		1,000	--	
Fluoride	µg/L	4,000		2,000	--	
Iron	µg/L	--		300	--	
Lead	µg/L	150		300	50	
Manganese and compounds	µg/L	--		50	--	
Mercury and compounds	µg/L	2		--	2	
Nickel	µg/L	100		--	--	
Nitrate	µg/L	10,000		--	10,000	
Nitrite	µg/L	1,000		--	--	
Selenium	µg/L	50		--	10	
Silver and compounds	µg/L	--		100	50	
Sulfate	µg/L	--		250,000	--	
Thallium	µg/L	2		--	--	
Zinc	µg/L	--		5,000	--	
Radium-226 and Radium-228	pCi/L	5	vi	--	5	vi
Uranium-234 and Uranium-238	pCi/L	--		--	30	vii
Gross alpha*	pCi/L	15	*	--	15	viii
pH (need to discern by 0.2 S.U.s)	S.U.	--		6.5 to 8.5	--	
Total dissolved solids	µg/L	--		500,000	--	
Turbidity	unit	1		--	--	

*Total Nitrate and Nitrite is 10,000 µg/L as N

*Includes radium-226 but excludes radon and uranium

****Total trihalomethane is 100 µg/L

v Total xylenes is 10,000 µg/L

vi Total radium-226 + radium-228

vii Total uranium-234 + uranium-238

viii Excludes radon and uranium

SECTION A

Project Management

Table A.7.2-5
PRELIMINARY ARARS FOR SURFACE WATER
(µg/L)

Chemical	Potentially Applicable									To Be Considered			
	Spokane Tribe Surface Water Quality Standards, Resolution No. 1999-169					1992 National Ambient Water Quality Criteria				1998 National Recommended Water Quality Criteria			
	Acute*	Chronic*	For HH Consumption of Water & Organisms*	For HH Consumption of Organisms Only*	Primary Contact and Spiritual Use*	Acute*	Chronic*	For HH Consumption of Water & Organisms*	For HH Consumption of Organisms*	Acute**	Chronic**	For HH Consumption of Water & Organisms*	For HH Consumption of Organisms Only*
Vinyl chloride	-	-	2	525	-	-	-	-	-	-	-	2.0 t	525 t
1,1-Dichloroethylene	-	-	0.057	3.2	-	-	-	0.057 s, t	3.2 s, t	-	-	0.057 s, t	3.2 s, t
Methylene chloride	-	-	4.7	1600	-	-	-	4.7 s, t	1,600 s, t	-	-	-	-
1,2-Dichloroethylene (trans)	-	-	700	140,000	-	-	-	-	-	-	-	700 s, bb	140,000 s
Chloroform	-	-	5.7	470	-	-	-	5.7 s, t	470 s, t	-	-	5.7 s, t	470 s, t
Carbon tetrachloride	-	-	0.25	4.4	-	-	-	0.25 s, t	4.4 s, t	-	-	0.25 s, t	4.4 s, t
Benzene	-	-	1.2	71	-	-	-	1.2 s, t	71 s, t	-	-	1.2 s, t	71 s, t
1,2-Dichloroethane (EDC)	-	-	0.38	99	-	-	-	0.38 s, t	99 s, t	-	-	0.38 s, t	99 s, t
Trichloroethylene (TCE)	-	-	0.8	8.85	-	-	-	2.7 t	81 t	-	-	2.7 t	81 t
1,2-Dichloropropane	-	-	0.52	39	-	-	-	-	-	-	-	0.52 s, t	39 s, t
1,3-Dichloropropene	-	-	-	-	-	-	-	-	-	-	-	10 s	1,700 s
Toluene	-	-	6,800	200,000	-	-	-	6,800 s	200,000 s	-	-	6,800 s, bb	200,000 s
1,1,2-Trichloroethane	-	-	0.6	42	-	-	-	0.60 s, t	42 s, t	-	-	0.060 s, t	42 s, t
Tetrachloroethylene (PCE)	-	-	0.8	8.85	-	-	-	0.8 t	8.85 t	-	-	0.8 t	8.85 t
Dibromochloromethane	-	-	-	-	-	-	-	0.27 s, t	22 s, t	-	-	-	-
Chlorobenzene	-	-	680	21,000	-	-	-	680 s	21,000 u	-	-	680 s, bb	21,000 s, u
Ethylbenzene	-	-	3,100	29,000	-	-	-	3,100 s	29,000 s	-	-	3,100 s, bb	29,000 s
Bromoform (tribromomethane)	-	-	4.3	360	-	-	-	4.3 s, t	360 s, t	-	-	4.3 s, t	360 s, t
1,1,2,2-Tetrachloroethane	-	-	0.17	11	-	-	-	0.17 s, t	11 s, t	-	-	0.17 s, t	11 s, t
Acenaphthene	-	-	1,200	2,700	-	-	-	-	-	-	-	1,200 s, aa	2,700 s, aa
Fluorene	-	-	1,300	14,000	-	-	-	1,300 s	14,000 s	-	-	1,300 s	14,000 s
Anthracene	-	-	9,600	110,000	-	-	-	9,600 s	110,000 s	-	-	9,600 s	110,000 s
Fluoranthene	-	-	300	370	300	-	-	300 s	370 s	-	-	300 s	370 s
Pyrene	-	-	960	11,000	-	-	-	960 s	11,000 s	-	-	960 s	11,000 s
Benz[a]anthracene	-	-	0.0044	0.049	-	-	-	0.0028 t	0.031 t	-	-	0.0044 s, t	0.049 s, t
Chrysene	-	-	0.0044	0.049	-	-	-	0.0028 t	0.031 t	-	-	0.0044 s, t	0.049 s, t
Benzo[b]fluoranthene	-	-	0.0044	0.049	-	-	-	0.0028 t	0.031 t	-	-	0.0044 s, t	0.049 s, t
Benzo[k]fluoranthene	-	-	0.0044	0.049	-	-	-	0.0028 t	0.031 t	-	-	0.0044 s, t	0.049 s, t
Benzo[a]pyrene	-	-	0.0044	0.049	-	-	-	0.0028 t	0.031 t	-	-	0.0044 s, t	0.049 s, t
Indeno[1,2,3-cd]pyrene	-	-	0.0044	0.049	-	-	-	0.0028 t	0.031 t	-	-	0.0044 s, t	0.049 s, t
Dibenz[ah]anthracene	-	-	0.0044	0.049	-	-	-	0.0028 t	0.031 t	-	-	-	-
1,2-dichlorobenzene	-	-	2,700	17,000	-	-	-	2,700	17,000	-	-	2,700	17,000
1,3-dichlorobenzene	-	-	400	2,600	-	-	-	400	2,600	-	-	400	2,600
1,4-dichlorobenzene	-	-	400	2,600	-	-	-	400	2,600	-	-	400	2,600
1,2,4-trichlorobenzene	-	-	260	940	-	-	-			-	-	260	940
Aluminum	750	87	-	-	50	-	-	-	-	750 dd, x	87 dd,x,ee	-	-

SECTION A

Project Management

Table A.7.2-5
PRELIMINARY ARARS FOR SURFACE WATER
(µg/L)

Chemical	Potentially Applicable									To Be Considered			
	Spokane Tribe Surface Water Quality Standards, Resolution No. 1999-169					1992 National Ambient Water Quality Criteria				1998 National Recommended Water Quality Criteria			
	Acute*	Chronic*	For HH Consumption of Water & Organisms*	For HH Consumption of Organisms Only*	Primary Contact and Spiritual Use*	Acute*	Chronic*	For HH Consumption of Water & Organisms*	For HH Consumption of Organisms*	Acute**	Chronic**	For HH Consumption of Water & Organisms*	For HH Consumption of Organisms Only*
Antimony	-	-	14	4,300	6	-	-	14 s	4,300 s	-	-	14 s,bb	4,300 s
Arsenic	360 a	190 a	0.018 a	0.14 a	500	360	190	0.018 a,s,t	0.14 a,s,t	340	150	0.018 t,y	0.14 t,y
Barium	-	-	-	-	2,000	-	-	-	-	-	-	-	-
Beryllium	-	-	-	-	4	-	-	-	-	-	-	-	-
Cadmium	19 b	3.4 b	-	-	5	19 g	3.4 g	-	-	19 v	6.2 v	-	-
Chromium	-	-	-	-	100	-	-	-	-	-	-	-	-
Chromium +3	5,400 b	640 b	-	-	-	5,400 g	640 g	-	-	1,800 v	230 v	-	-
Chromium +6	16	11	-	-	-	16	11	-	-	16 v	11	-	-
Copper	65 b	39 b	-	-	1,000	65 g	39 g	-	-	50 v	29 v	1,300 aa	-
Iron	-	1,000	300	-	-	-	-	-	-	-	1,000 ff	300 gg	-
Lead	480 b	19 b	-	-	-	480 g	19 g	-	-	280 v	11 v	-	-
Manganese	-	-	50	-	50	-	-	-	-	-	-	-	-
Mercury	2.4	0.012 d	0.14	0.15	2	2.4	0.012 q	0.14	0.15	1.4 n	0.77 n	0.050 s	0.051 s
Nickel	4,600 b	510 b	610	4,600	-	4,600 g	510 g	610 s	4,600 s	1,500 v	168 v	610 s	4,600 s
Selenium	20	5	-	-	50	20	5	-	-	w,x	4.6	170 bb	11,000
Silver	44 b	-	-	-	100	44 g	-	-	-	37 v	-	-	-
Thallium	-	-	1.7	6.3	2	-	-	1.7 s	6.3 s	-	-	1.7 s	6.3 s
Zinc	380 b,c	340 b	-	-	5,000	380 g	340 g	-	-	380 v	380 v	9100 aa	69,000 aa
Cyanide	22 r	5.2 r	700 r	220,000 r	200 r	22 r	5.2 r	700 s	220,000 s,u	22 r	5.2 r	700 s,bb	220,000 s,u,tt
Chloride	860,000	230,000	-	-	250,000	-	-	-	-	860,000 dd	230,000 dd	-	-
Sulfate	-	-	250,000	-	250,000	-	-	-	-	-	-	-	-
Nitrate	-	-	-	-	10,000 as N	-	-	-	-	-	-	10,000 gg	-
Nitrite	-	-	-	-	1,000 as N	-	-	-	-	-	-	-	-
pH	-	-	-	-	6.5-8.5	-	-	-	-	-	6.5-9 ff	5-9	-
Dissolved Oxygen	-	-	-	-	-	-	-	-	-	hh	hh	hh	hh
Total dissolved solids	-	-	-	-	500,000	-	-	-	-	-	-	250,000 gg	-
Alkalinity	-	-	-	-	-	-	-	-	-	-	20,000 ff	-	-
Gross alpha (pCi/l)	-	15cc	-	-	-	-	-	0.0039 s, t	0.013 s, t	-	-	0.0039 s, t	0.013 s, t
Gross beta (pCi/l)	-	50	-	-	-	-	-	0.014 s, t	0.046 s,t	-	-	0.014 s, t	0.046 s, t
Radionuclides– See note z at end of this table													

Notes:

* Except as noted, values are expressed as total criteria.

** Except as noted, values are expressed as dissolved criteria.

a = The aquatic life criteria refer to the trivalent form only. The human health criteria refer to the inorganic form only.

b = Freshwater aquatic life criteria for these metals are expressed as a function of total hardness (mg/L CaCO₃) according to the equations below. The factors for the equations are provided in the following matrix. Values in the above table correspond to a hardness of 400 mg/L, which is representative of typical surface water concentrations in Blue Creek. The historic hardness of Blue Creek upgradient of mine drainage ranges from 40 to 60 mg/l (Sumioka 1991). Hardness dependent ARARs will be calculated based on actual sample hardness values.

Acute criterion = exp{m [Ln(hardness)] + b} where Ln is natural logarithm

Chronic criterion = exp {m [Ln(hardness)] +b}

SECTION A

Project Management

Table A.7.2-5
PRELIMINARY ARARS FOR SURFACE WATER
(µg/L)

SPOKANE TRIBE RES. NO. 1999-169 FACTORS FOR CALCULATING METALS CRITERIA				
Metal	Acute		Chronic	
	m	b	m	B
Cadmium	1.128	-3.828	0.7852	-3.490
Copper	0.9422	-1.464	0.8545	-1.465
Chromium (III)	0.8190	3.688	0.8190	1.561
Lead	1.273	-1.460	1.273	-4.705
Nickel	0.8460	3.3612	0.8460	1.1645
Silver	1.72	-6.52	N/A	N/A
Zinc	0.8473	0.8604	0.8473	0.7614

- c Equation presented in footnote b is used even though Table 1 of Spokane Tribe Resolution No. 1999-169 provides an acute value of 120 µg/L for zinc that is not footnoted. The lack of a footnote appears to be a typographical error since factors to calculate an acute value for zinc based on a hardness other than 100 mg/L as CaCO₃ are provided in the same regulation.
- d = Criterion is based on protection of human health from fish consumption not protection of aquatic life.
- e = A 1-hour average concentration not to be exceeded more than once every 3 years on the average.
- f = A 4-day average concentration not to be exceeded more than one every 3 years on the average.
- g = Factors and equations for calculating acute and chronic criterion are the same as those in Note b.
- h = Uses the same hardness dependent equation, associated factors, and hardness of 400 mg/L (as CaCO₃) as provided in footnote b. The result is multiplied by a conversion factor (CF) to calculate a dissolved criterion. CFs, some of which are hardness dependent, are provided in the following table:

WASHINGTON STATE CONVERSION FACTORS FOR CALCULATING DISSOLVED METALS CRITERIA		
Metal	Acute	Chronic
Arsenic	1	1
Cadmium	CF = 1.136672 - [(Ln hardness)(0.041838)]	CF = 1.101672 - [(Ln hardness)(0.041838)]
Chromium (III)	0.316	0.860
Chromium (IV)	0.982	0.962
Copper	0.960	0.960
Lead	CF = 1.46203 – [(Ln hardness)(0.145712)]	CF = 1.46203 – [(Ln hardness)(0.145712)]
Nickel	0.998	0.997
Silver	0.850	N/A
Zinc	0.978	0.986

- i = Where methods to measure trivalent chromium are unavailable, these criteria are to be represented by total-recoverable chromium.
- j = Conversion factor to calculate dissolved metal concentration is 0.982. Salinity-dependent effects. At low salinity, the 1-hour average may not be sufficiently protective.
- k = Conversion factor to calculate dissolved metal concentration is 0.962
- l = If the four-day average chronic concentration is exceeded more than once in a 3-year period, the edible portion of the consumed species should be analyzed. Said edible tissue concentrations shall not be allowed to exceed 1.0 mg/kg of methylmercury.
- m = Conversion factor to calculate dissolved metal concentration is 0.85
- n = These criteria are based on the total-recoverable fraction of the metal.
- o = The criteria for cyanide is based on the weak acid dissociable method in the 17th Ed. Standard Methods for the Examination of Water and Wastewater, 4500-CNI, and as revised.
- p = An instantaneous concentration not to be exceeded at any time.
- q = If the CCC for total mercury exceeds 0.012 µg/L more than once in a 3-year period in the ambient water, the edible portion of aquatic species of concern must be analyzed to determine whether the concentration of methyl mercury exceeds the FDA action level (1.0 mg/kg). If the FDA action level is exceeded, the State must notify the appropriate EPA Regional Administrator, initiate a revision of its mercury criterion in its water quality standards so as to protect designated uses, and take other appropriate action such as issuance of a fish consumption advisory for the affected area.
- r = Expressed as µg free cyanide (as CN)/L.
- s = Criteria revised to reflect current agency q¹* or RfD, as contained in the Integrated Risk Information System (IRIS) as of April 8, 1998. The fish tissue bioconcentration factor (BCF) from the 1980 criteria documents was retained in all cases.
- t = Criteria in the matrix based on carcinogenicity (10⁻⁶ risk).
- u = No criteria for protection of human health from consumption of aquatic organisms (excluding water) was presented in the 1980 criteria document or in the 1986 Quality Criteria for Water. Nevertheless, sufficient information was presented in the 1980 document to allow a calculation of a criterion, even though the results of such a calculation were not shown in the document.

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Table A.7.2-5
PRELIMINARY ARARS FOR SURFACE WATER
(µg/L)

v = Freshwater criterion for this metal is expressed as a function of total hardness (mg/L CaCO₃) in the water column according to the following equations: CMC (dissolved) = exp {m_A [Ln(hardness)] + b_A} (CF), or CCC (dissolved) = exp {m_C [Ln(hardness)]+ b_C} (CF). The factors for the equations are provided in the following matrix.

1999 FWQC FACTORS FOR CALCULATING METALS CRITERIA						
Chemical	m _A	b _A	m _C	b _C	Total Dissolved Conversion Factors (CFs)	
					Acute	Chronic
Cadmium	1.128	-3.6867	0.7852	-2.715	1.136672-[Ln (hardness)(0.041838)]	1.101672-[Ln (hardness)(0.041838)]
Chromium III	0.8190	3.7256	0.8190	0.6848	0.316	0.860
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	1.46203-[Ln (hardness)(0.145712)]	1.46203-[Ln (hardness)(0.145712)]
Nickel	0.8460	2.255	0.8460	0.0584	0.998	0.997
Silver	1.72	-6.52	--	--	0.85	--
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

w = The CMC = 1/[(f1/CMC1) = (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 µg/L and 12.83 µg/L, respectively.

x = This recommended water quality criterion is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor of 0.922; which was used in the GLI to convert this to a value that is expressed in terms of dissolved metal.

y = This recommended water quality criterion refers to the inorganic form only.

z = Spokane Indian Tribe water quality criteria for radionuclides:

Analyte	pCi/L	Analyte	pCi/L	Analyte	pCi/L
Ac ²²⁷	1.00	Ra ²²³	1.00	Th ²³¹	1.00
Bi ²¹⁰	1.00	Ra ²²⁴	1.00	Th ²³²	0.30
Pa ²³¹	1.00	Ra ²²⁶	0.60	Th ²³⁴	0.30
Pb ²⁰⁶	1.00	Ra ²²⁸	0.60	Tl ²⁰⁶	1.00
Pb ²⁰⁷	1.00	Rn ²²²	0.20	U ²³⁴	3.00
Pb ²⁰⁸	1.00	Th ²²⁷	1.00	U ²³⁵	3.00
Pb ²¹⁰	0.10	Th ²²⁸	1.00	U ²³⁸	3.00
Po ²¹⁰	0.40	Th ²³⁰	0.20	U _{nat}	3.00

aa = The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.

bb = A more stringent MCL has been issued by EPA.

cc = Includes radium-226 but excludes radon and uranium.

dd = This criterion is based on 304(a) aquatic life criterion issued in 1980

ee = There are three major reasons why the use of Water-Effect Ratios might be appropriate. (1) The value of 87 µg/l is based on a toxicity test with the striped bass in water with pH=6.5-6.6 and hardness <10 mg/L. Data in “Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia” (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicting that total recoverable procedure is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg aluminum/L, when either total recoverable or dissolved is measured.

ff = The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976)

gg = This human health criterion is the same as originally published in the Red Book which predates the 1980 methodology and did not utilize the fish ingestion BCF approach. This same criterion value is now published in the Gold Book.

hh = Warmwater and coldwater matrix – see document: U.S. EPA. 1986. Ambient Water Quality Criteria for Dissolved Oxygen. EPA 440/5-86-003.

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Table A.7.2-6

**STATISTICAL HYPOTHESES FOR COMPARISON OF SURFACE WATER,
SEDIMENT, AND GROUNDWATER TO BACKGROUND**

True Condition	Results of Statistical Test	
	Accept H_0	Reject H_0
Null hypothesis H_0 : $S < \text{Upper Prediction Limit}$	<i>Correct Decision</i>	<p><i>Type I Error</i> = alpha False Positive Decision Rate</p> <p>Consequence: Decide that PIA chemical/radionuclide concentration exceeds the background concentration when it does not. This decision results in unnecessary expenditure of time and monetary resources to calculate risk and may result in unnecessary remediation of environmental media.</p>
Alternative hypothesis H_A : $S > \text{Upper Prediction Limit}$	<p><i>Type II Error</i> = beta False Negative Decision Rate</p> <p>Consequence: Decide that the PIA chemical/radionuclide concentration does not exceed the background concentration when it does resulting in a potential unacceptable risk to human health and the environment.</p>	<i>Correct Decision</i>

Notes:

S = individual PIA sample result for a given medium (S may be zero to 2 verification samples [see Section A.7.3.2.2]).

Upper Prediction Limit = background concentration limit.

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Table A7.3-1
SAMPLE SIZE REQUIREMENTS TO ACHIEVE OR
EXCEED EPA (1992) REFERENCE POWER CURVE

(Nonparametric prediction limit method is assumed for comparing background and site data).

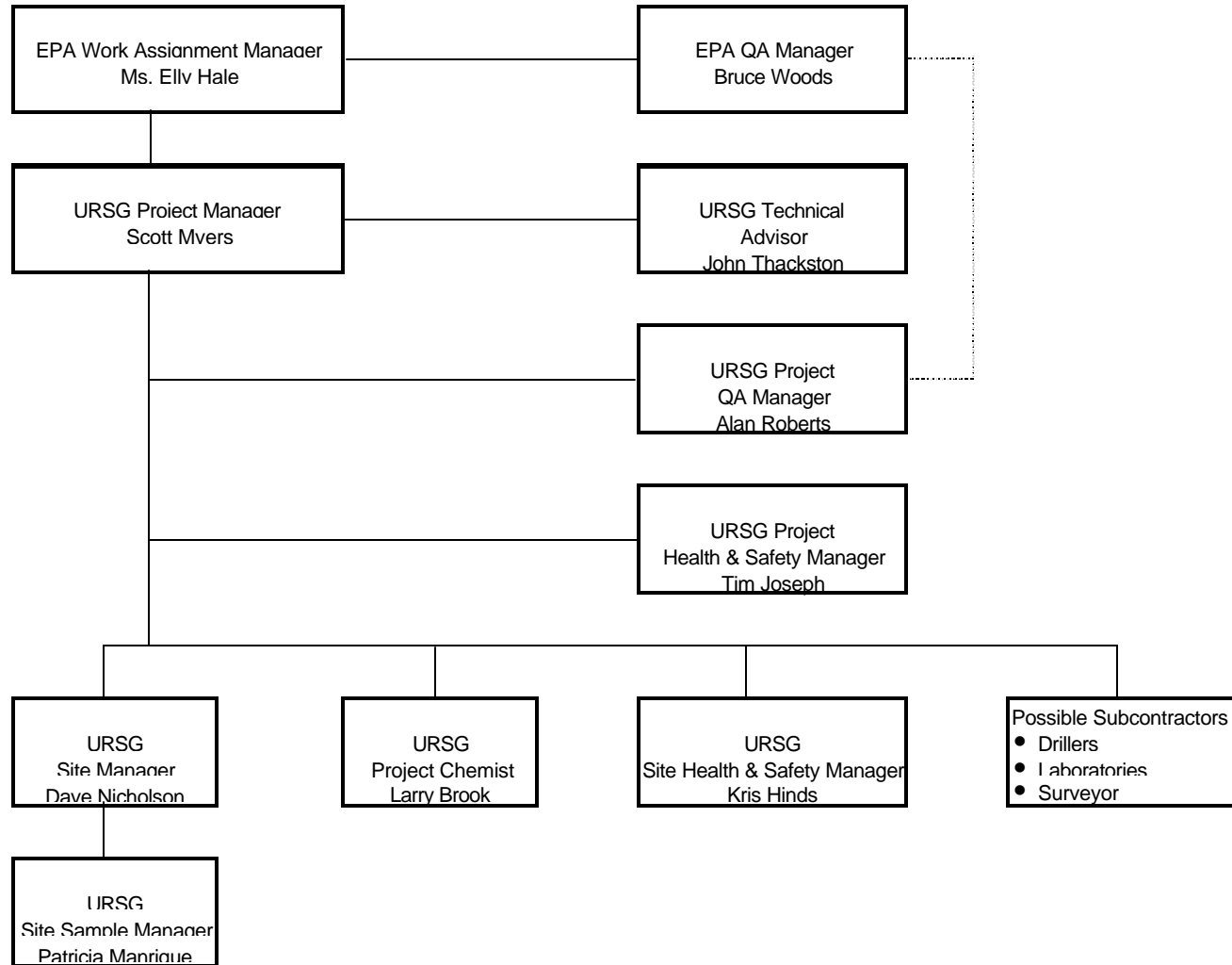
Number of Future Comparisons	Number of Verification Samples					
	0		1 ^(a)		2 ^(b)	
	Number of Background Samples	Type I Error, %	Number of Background Samples	Type I Error %	Number of Background Samples	Type I Error, %
5	24	20	16	5	8	5
20	24	45	16	10	16	5
50	32	60	24	10	16	5
100	32	60	24	20	16	5
200			32	20	16	10
300			40	20	16	15

^(a) One verification sample must be at or below background for an individual sample location to be considered within background.

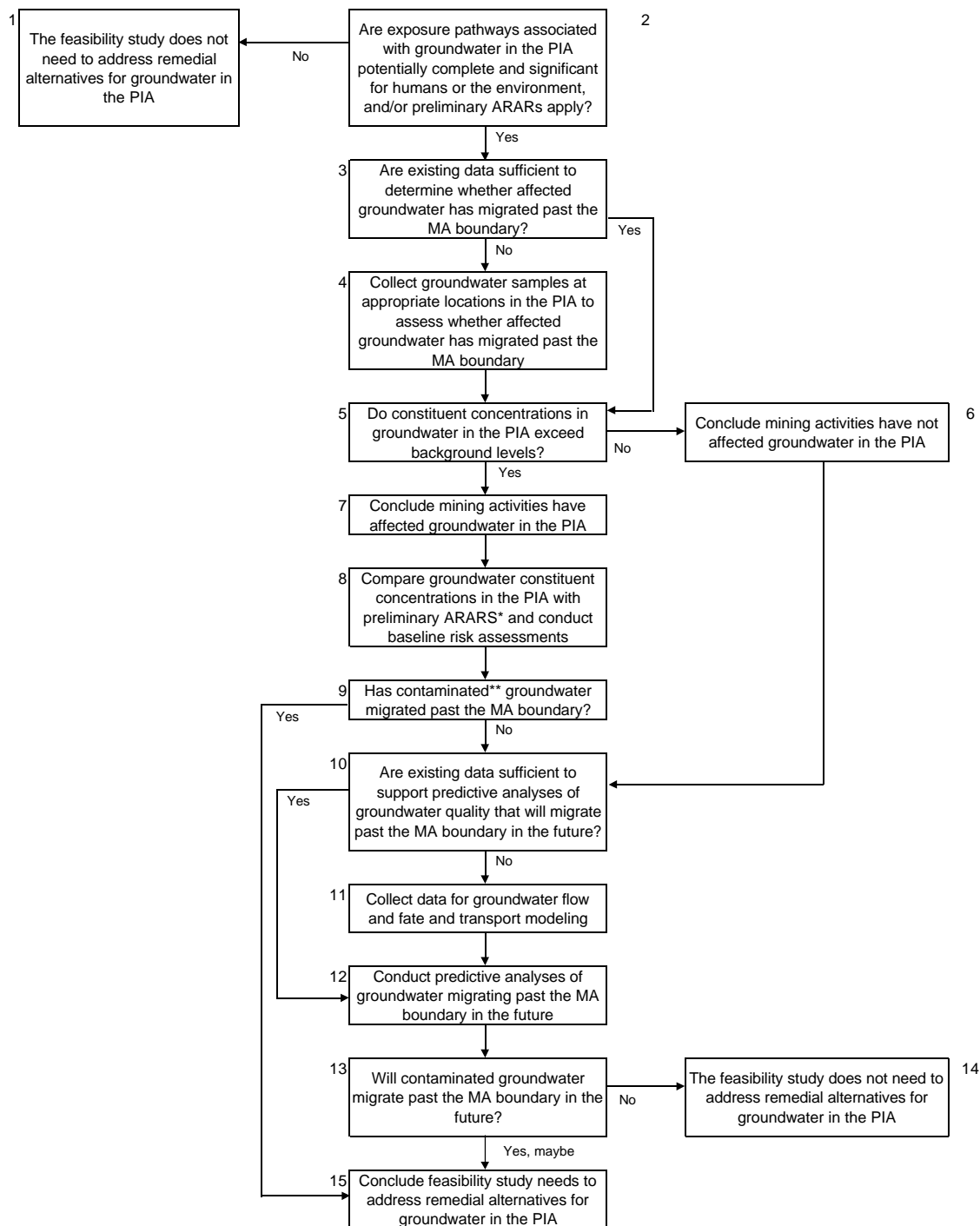
^(b) Two verification samples, both must be at or below background for an individual sample location to be considered within background.

Figure A.4-1

PROJECT ORGANIZATION CHART FOR THE MIDNITE MINE RI/FS



**Figure A7.2-6
DECISION FLOW CHART FOR GROUNDWATER IN THE PIA**



*Preliminary ARARs include state, federal, and tribal standards

**Groundwater is contaminated if chemical/radiological constituents exceed preliminary ARARs or pose an unacceptable risk to humans or the environment.

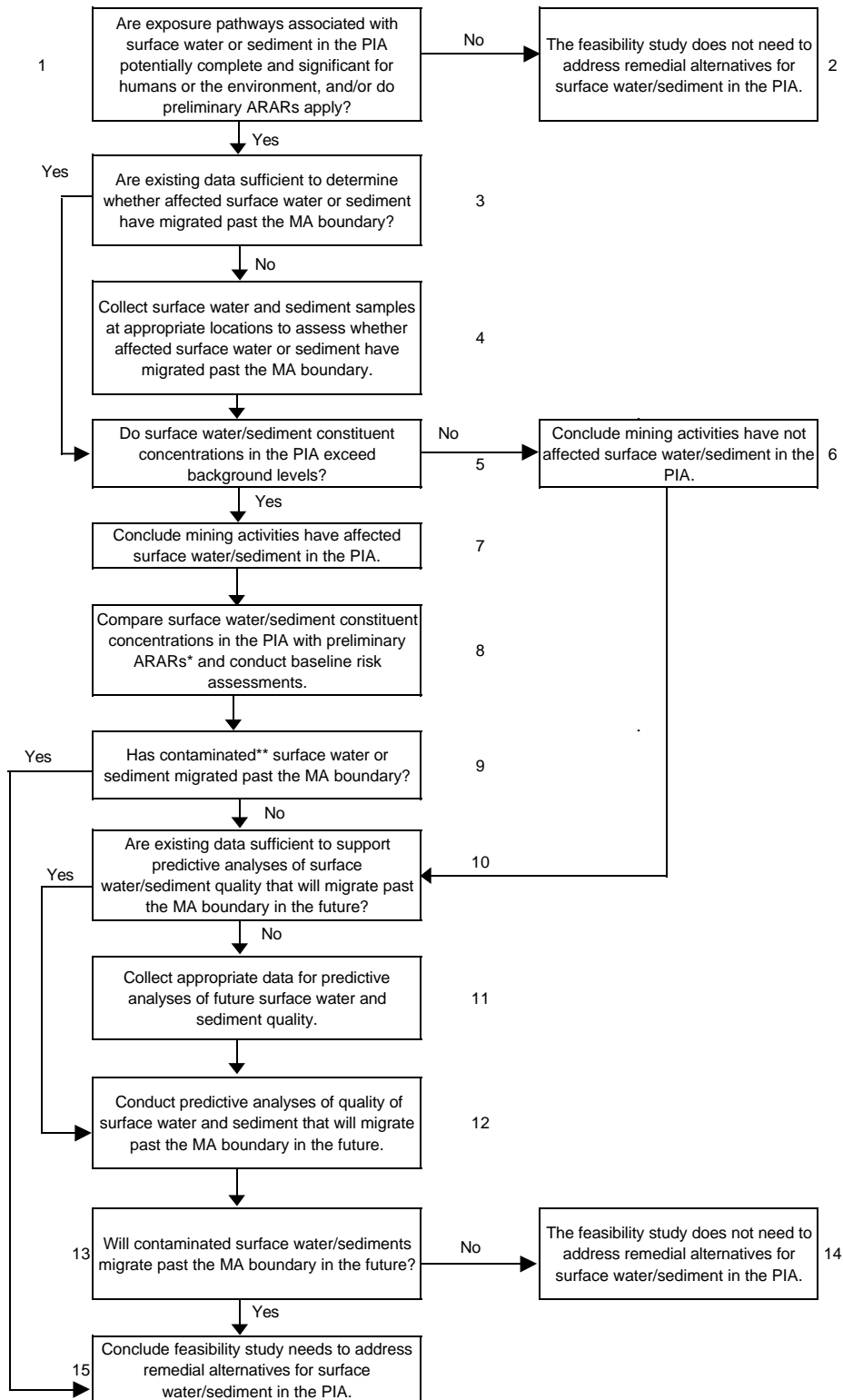
PIA - Potentially Impacted Area

MA - Mined Area

ARAR - Applicable or Relevant and Appropriate Requirements

Seep/spring water is considered groundwater for this decision flow chart

Figure A7.2-7
DECISION FLOW CHART FOR SURFACE WATER AND SEDIMENT IN THE PIA



* Preliminary ARARs include state, federal, and tribal standards

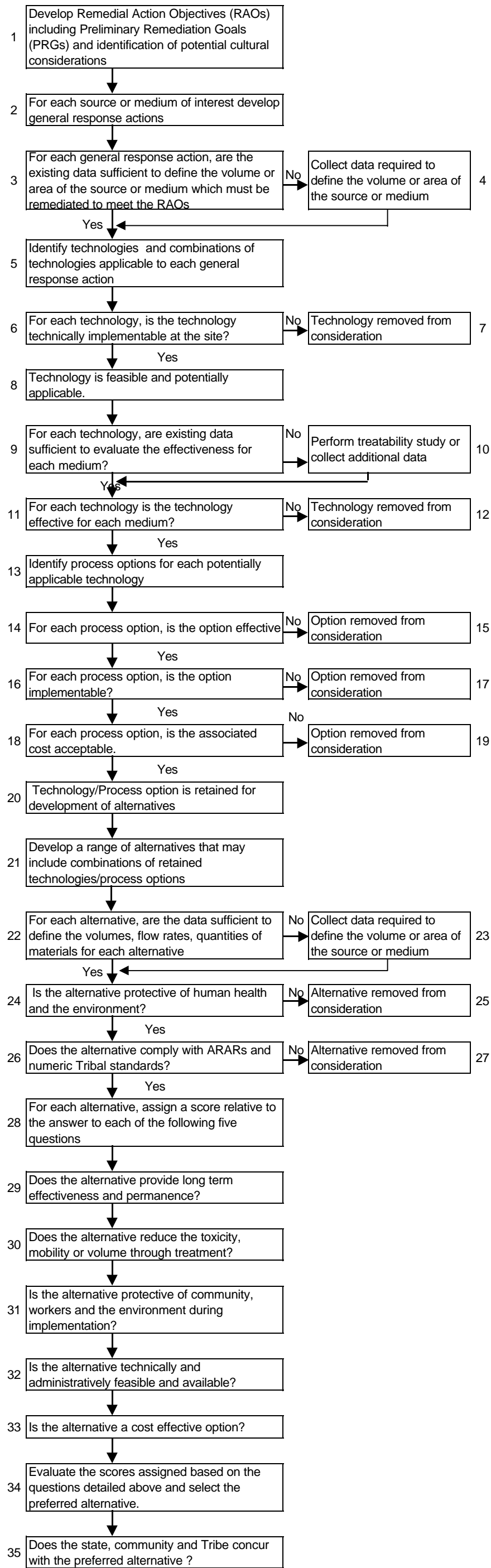
**Surface water or sediment is contaminated if chemical/radiological constituents exceed preliminary ARARs or pose an unacceptable risk to humans or the environment.

PIA - Potentially Impacted Area

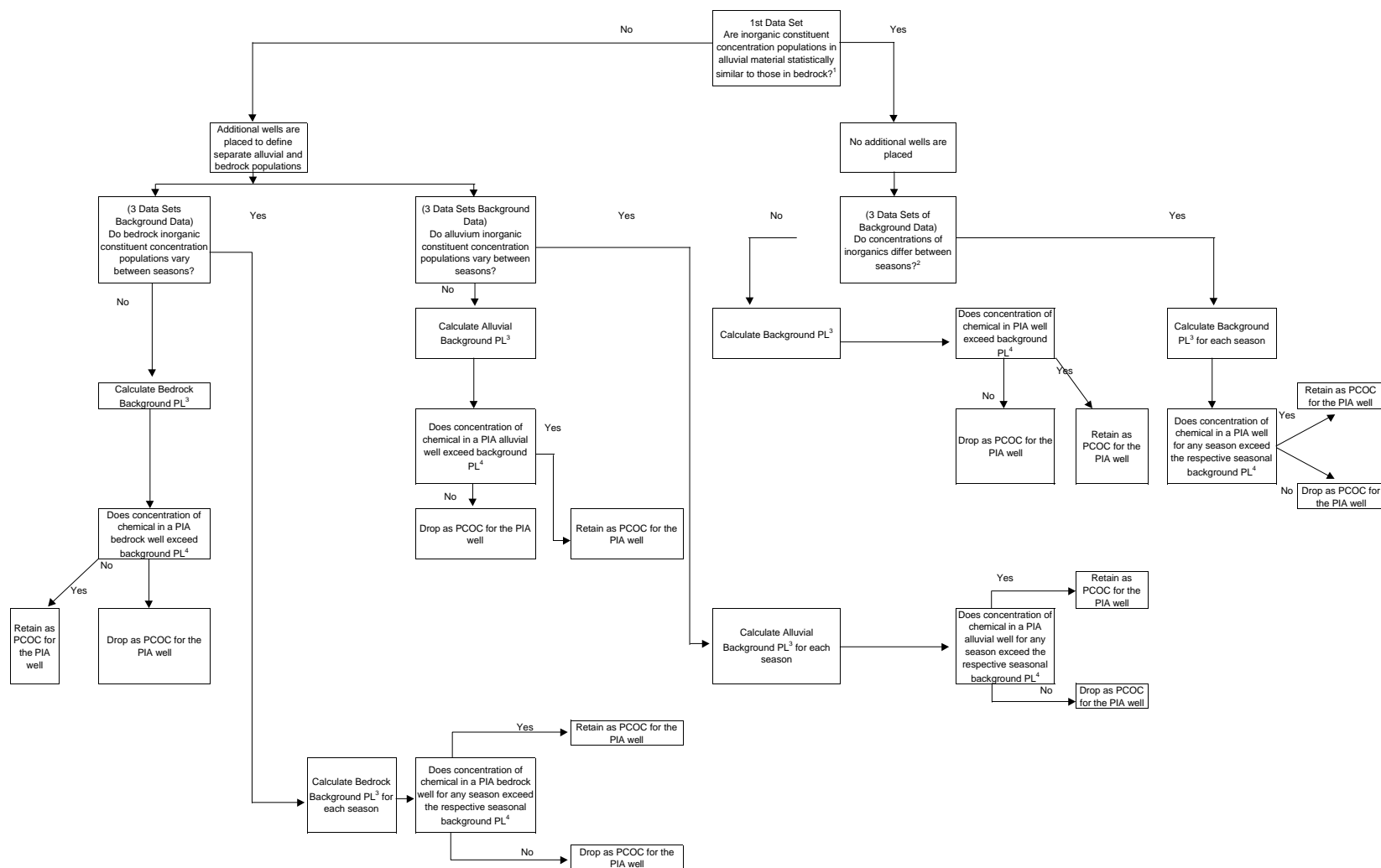
MA - Mined Area

ARAR - Applicable or Relevant and Appropriate Requirements

Figure A.7.2-8
DECISION FLOW CHART FOR FEASIBILITY STUDY



**Figure A.7.3-1
FLOW CHART FOR COMPARISON APPROACH OF
PIA GROUNDWATER CONCENTRATIONS AT EACH WELL TO BACKGROUND CONCENTRATIONS**



¹ Normality and/or lognormality of the data are first tested. If the data are normal or lognormal, the student's t-test is used to test this hypothesis. If the data are neither normal or lognormal the Wilcoxon Signed Rank test is used.

² Normality and/or lognormality of the data are first tested. If the data are normal or lognormal, the ANOVA test is used to test this hypothesis. If the data are neither normal or lognormal the Kruskal-Wallis test is used.

³ Calculate 95% prediction limit (PL). If data are normally or lognormally distributed, use parametric method for calculating limit. If data are neither normal or lognormal use the nonparametric method for calculating limit.

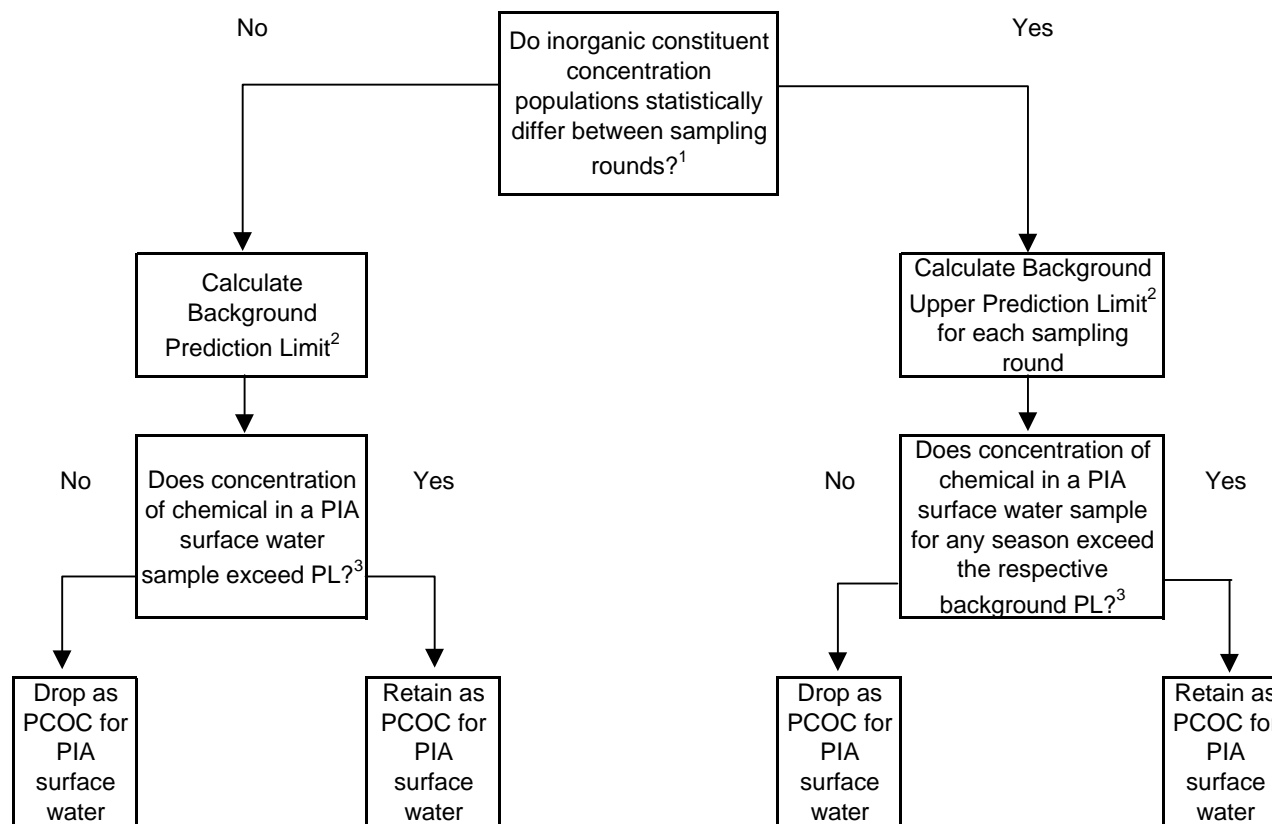
⁴ Comparison is done for each chemical in each PIA well.

PL = Prediction Limit

PIA = Potentially Impacted Area

PCOC = Potential Chemical of Concern

Figure A.7.3-2
FLOW CHART FOR COMPARISON APPROACH OF
PIA SURFACE WATER CONCENTRATIONS AT EACH SAMPLING LOCATION TO BACKGROUND CONCENTRATIONS



¹ Normality and/or lognormality of the data are first tested. If the data are normal or lognormal the ANOVA test is used to test this hypothesis. If the data are neither normal or lognormal the Kruskal-Wallis test is used.

² Calculate 95% prediction limit (PL). If data are normally or lognormally distributed use parametric method for calculating limit. If data are neither normal or lognormal use the nonparametric method for calculating limit.

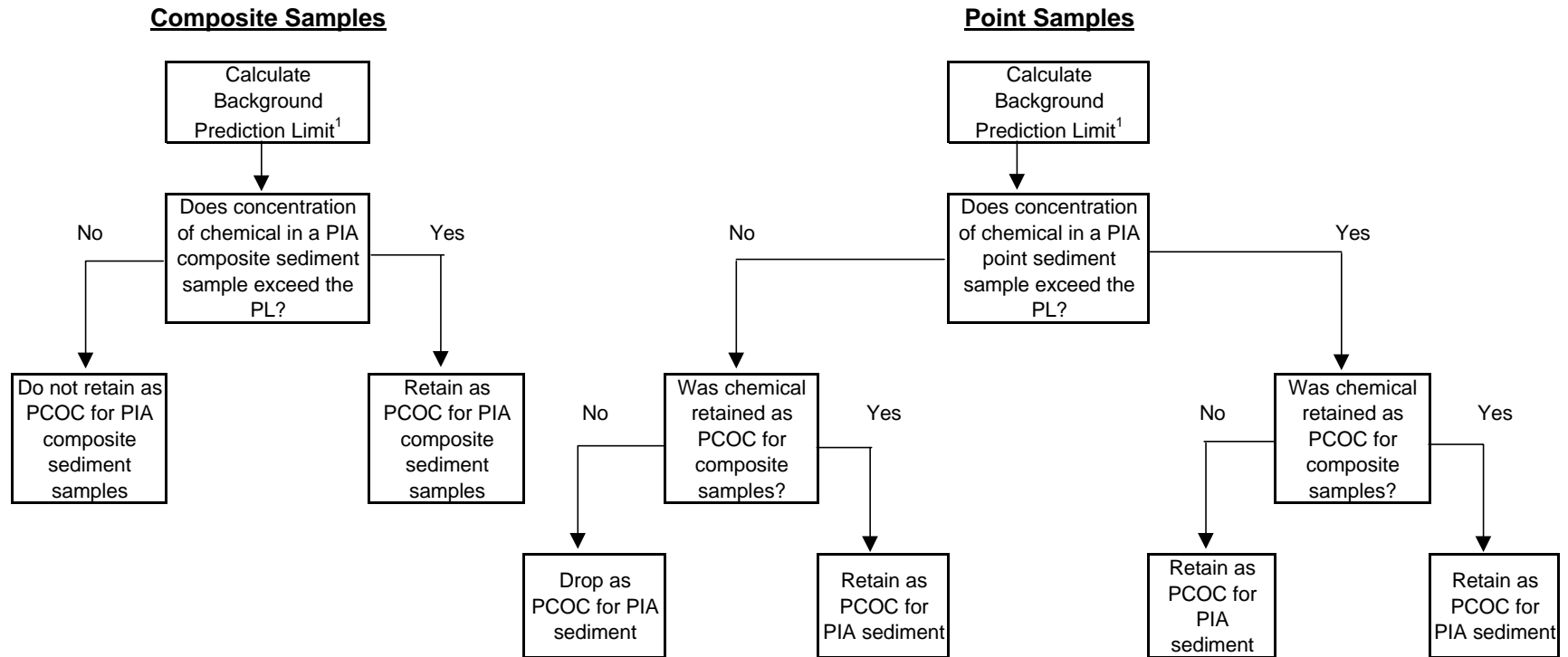
³ Comparison is done for each chemical.

PL = Prediction Limit

PIA = Potentially Impacted Area

PCOC = Potential Chemical of Concern

Figure A.7.3-3
FLOW CHART FOR COMPARISON APPROACH OF
PIA SEDIMENT CONCENTRATIONS AT EACH SAMPLING LOCATION TO BACKGROUND CONCENTRATIONS



¹ Calculate 95% prediction limit (PL). If data are normally or lognormally distributed use parametric method for calculating limit.

If data are neither normal or lognormal use the nonparametric method for calculating limit.

PL = Prediction Limit

PIA = Potentially Impacted Area

PCOC = Potential Chemical of Concern

SECTION B

Measurement/Data Acquisition

B.1 SAMPLING PROCESS DESIGN (EXPERIMENTAL DESIGN)

B.1.1 Purpose and Background

This section presents the groundwater, surface water, and sediment sampling program for the Midnite Mine Phase 1A RI/FS. The program consists of two main components:

1. Groundwater, surface water, and sediment sampling in the PIA.
2. Groundwater, surface water, and sediment sampling for characterization of Background Area concentrations.

This section is presented in a series of tables and maps. Table A7.2-2 and A7.2-3, and Figures A7.2-9 through A7.2-11 provide the output of the DQO process for groundwater, surface water and sediment sampling in the PIA and for the background characterization, respectively. They present the proposed sampling activities, locations, frequencies, and sampling rationale and design assumptions.

B.1.2 Schedule of Project Activities, Including Measurement Activities

The estimated schedule for planning and field investigation activities is presented in Section A.6.

B.1.3 Rationale for the Design

The rationale for the design of the sampling program is presented in Tables A7.2-2 and A7.2-3 for groundwater, surface water, and sediment in the PIA and the Background Area, respectively.

B.1.4 Design Assumptions

Design assumptions for the sampling program are presented in Tables A7.2-2 and A7.2-3 for groundwater, surface water, and sediment in the PIA and the Background Area, respectively.

B.1.5 Procedures for Locating and Selecting Environmental Samples

The basis for locating and selecting environmental samples for the sampling program is presented in Tables A7.2-2 and A7.2-3 for groundwater, surface water and sediment in the PIA and the Background Area, respectively. Monitoring well and sampling locations are shown on Figures A7.2-9 through A7.2-11.

B.1.6 Classification of Measurements as Critical or Noncritical

All proposed measurements are critical for resolving the decision statements identified in Section A7.

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B.2 SAMPLING METHODS REQUIREMENTS

B.2.1 Purpose/Background

The quality of data collected in an environmental study is critically dependent upon the quality and thoroughness of field sampling activities. General field operations and practices and specific sample collection and inventory will be well planned and carefully implemented. The Phase 1A RI/FS field investigation SAP (Appendix A of the QAPP) provides detailed descriptions of the sampling program.

B.2.2 Sample Collection, Preparation, and Decontamination Procedures

Standard sample collection procedures and data collection forms have been developed for sampling and related data gathering activities. The purpose for these procedures is to obtain samples that represent the environment under investigation. The procedures that will be used for sample collection and preparation for this investigation are included in the project SOPs (Appendix B), while the data collection forms used to document this investigation are included as Appendix C. Should samples be analyzed through the EPA Contract Laboratory Program, samples will be handled and documented in accordance with the EPA Sampler's Guide to the Contract Laboratory Program (EPA 1996). Decontamination is discussed in the SAP (Appendix A) and within the SOP for decontamination (Appendix B).

A discussion of sample type (grab or composite), location and collection technique is included in the SAP, while a summary of sample containers, volume and preservation is included in Table B.4.3-1. Sediment samples will be homogenized in the field prior to collection into sample containers and again at the laboratory prior to analysis.

While recognizing the importance of striving to meet all project-required detection/quantitation limits, an effort will be made to have one laboratory complete all analytes from a given analytical suite (e.g., anions, VOCs, SVOCs, etc.). However, laboratory limitations may necessitate that an analytical suite be split amongst two (or more) laboratories. For example, arsenic from the CLP Target Analyte List (TAL) of metals may require analysis by ICP-MS to attain the project-required detection limit. Should the prime-contracted analytical laboratory for CLP TAL metals not have ICP-MS capabilities, a second laboratory will be contracted to augment the abilities of the prime laboratory.

A Management Systems Review (MSR) is scheduled for each subcontracted laboratory prior to sample collection (Section C.1.2.1). As part of the laboratory MSR, the contracted laboratory should provide at least the most recent two sets of Performance Evaluation (PE) sample results for each method to be performed from their participation in the National Voluntary Laboratory Accreditation Program, EPA laboratory proficiency program, or EPA interlaboratory studies. Additional PE samples specific to project-related contaminants of concern may be submitted with the Phase 1A environmental samples. Historical PE sample performance, participation in accreditation programs, participation in interlaboratory studies, and completion of project PE samples can all be used to understand the laboratory's ability to successfully perform a given

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method. Laboratory performance within these programs will assist in a quantitative understanding of laboratory bias and can be used to increase (or at least measure) comparability between laboratories contracted to complete a split analytical suite.

B.2.3 Sampling/Measurement System Failure Response and Corrective Action Process

During pre-mobilization activities for the Phase 1A field investigation, a field reconnaissance will be completed to locate and stake each proposed sampling location. Any location accessibility problems will be identified at that time and the Site Manager will propose an alternate location meeting the data need intended by the original location. This decision would be made with concurrence from the URSG Project Manager. If an alternate location is not available or accessible which still meets the original data need, the URSG Project Manager will be consulted to determine the proper course of action. Any changes to the QAPP and SAP will be documented in the field logbook and recorded in the Daily Quality Control Report Form (Appendix C).

Any serious flaws noted during implementation of the SAP and/or during completion of a technical systems audit (Section C.1) will be documented in the field logbook and recorded in the Daily Quality Control Report Form and brought to the attention of the Site Manager. The content and frequency of technical systems audits is discussed in Section C.1. The Site Manager will notify the URSG Project Manager as necessary to determine what corrective actions might be necessary and appropriate.

Any serious flaws noted prior to demobilization from the Phase 1A field investigation which result in lost data will be rectified as achievable prior to demobilization. For example, any missed sample holding times may require the collection of additional sample prior to demobilization to satisfy the original data need.

B.2.4 Sampling Equipment, Preservation, and Holding Time Requirements

A description of sample equipment to be used and a discussion of steps taken to mitigate sample contamination are included in the SAP (Appendix A), and supporting SOPs (Appendix B). Sample preservation, container, volume, and maximum holding time requirements are described in Section B.4 of this QAPP. As available, certified clean sample containers will be procured from a subcontracted analytical laboratory or vendor for use in sample collection.

B.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

B.3.1 Purpose/Background

Written documentation of sample custody from the time of sample collection through the generation of data by analysis of that sample is recognized as a vital aspect of an environmental study. The chain-of-custody of the physical sample and its corresponding documentation will be maintained throughout the handling of the sample. All samples will be identified, labeled, and logged onto a chain-of-custody form, as a part of the procedure designed to assure the integrity

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of the resulting data. The record of the physical sample (location and time of sampling) will be joined with the analytical results through accurate accounting of the sample custody. As described below, sample custody applies to both field and laboratory operations. Official custody of samples will be maintained from the time of sample collection, through preparation and analysis, and until sample disposal.

B.3.2 Sample Custody

All laboratories completing chemical analyses will be required to maintain samples in a secure location with limited access from the time of sample receipt through sample disposal. Sample custody within a laboratory will be dependent upon the laboratory QAP and/or SOPs (Appendix E). The laboratory will be responsible for maintaining internal bound logbooks and records that provide an uninterrupted custody record throughout sample preparation and analysis. For field operations, standard sample collection procedures have been developed for sample custody, labeling, analysis request, and tracking (Appendix B). Sample custody procedures for field operations are summarized below.

A sample is under custody if it is in:

- The possession of the sampler
- The view of the sampler after being in the possession of the sampler
- The possession of the sampler and then placed in a secured location, or
- A designated secure area.

Waterproof ink will be used for the completion of chain-of-custody forms unless prohibited by weather conditions. For example, a log book notation will explain that a pencil was used to fill out the chain-of-custody form because the ballpoint pen would not function in freezing weather. Any necessary corrections are to be made by drawing a single line through the error, initialing and dating the error, then entering the correct information.

All samples will be accompanied by a properly completed chain-of-custody form. An example chain-of-custody form is included in Appendix C. The sample numbers, locations, and requested analyses will be listed. When transferring the possession of samples, the individuals relinquishing and receiving custody will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to the laboratory, and to/from a secure storage area. Chain of custody forms will be retained as part of the permanent documentation.

Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis. Shipping containers will be secured with strapping tape or equivalent. Custody seals will be placed on the shipping container for shipment to the laboratory. The preferred procedure is the attachment of a custody seal to the front right and back left of the cooler. The custody seals are covered with clear plastic tape. The cooler is strapped shut with strapping tape or equivalent in at least two locations. Once samples have arrived at the laboratory, sample custody will be handled in a fashion consistent with the laboratory QAPP and SOPs (Appendix E).

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The forms included as part of the Phase 1A field investigation program are examples and may change depending upon the laboratory selected to complete the analyses. Example sample label, chain of custody, and custody seal forms are included in Appendix C.

B.3.3 Sample Identification System

A sample numbering system has been developed for the Phase 1A field investigation and is discussed in the SAP (Appendix A).

B.3.4 Sample Shipment

Prior to sample shipment or delivery, samples will be screened for radioactivity as described in the Sampling Handling, Shipping, and Documentation SOP. If the samples are sent by common carrier, an air bill will be used. Receipts of air bills will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the chain-of-custody forms as long as the chain-of-custody forms are sealed inside the sample cooler and the custody seals remain intact.

Samples collected during this investigation will be either shipped to the laboratory via an overnight carrier or will be hand delivered to the analytical laboratory if geographically possible. If samples are shipped via an overnight carrier, the following procedure will be used for packaging (refer to the SOP in Appendix B for more detail).

- Inert cushioning material will be placed in the bottom of the cooler.
- The cooler will be lined with a large garbage bag.
- Each sample container will be sealed in a resealable plastic bag and placed upright in the cooler with ice for shipment.
- A bottle containing tap water and identified as a temperature blank will be included with each cooler containing samples cooled to 4 degrees Celsius. Upon receipt of the samples at the laboratory, the temperature blank will be used to determine the cooler temperature. The temperature blank will not be assigned a sample identification number and will not appear as a line item on the chain of custody form.
- Additional packaging materials will be placed around the containers as cushioning material.
- Pertinent paperwork, such as the chain-of-custody form, will be placed in a resealable plastic bag and taped to the inside lid of the cooler.
- The cooler will be sealed with packaging tape.
- A shipping label will be affixed to the outside of the cooler.
- Signed custody seals will be attached to the cooler in two places and covered with clear tape in such a way that the custody seals must be broken to open the cooler.

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B.3.5 Sample Container Tampering

If, at any time after samples have been secured, custody seals on the cooler are identified as having been tampered with, the following procedures will be conducted:

- Check with personnel having access to sample coolers to evaluate whether inadvertent tampering can be documented.
- Document findings of the incident in a logbook.

If it cannot be documented that inadvertent breaking of the custody seal that did not affect the integrity of samples has occurred, the samples will be re-collected and the Project Manager and QA Officer will be notified.

B.3.6 Sample Archival and Disposal

Groundwater, surface water and sediment sample aliquots will not be archived as a part of the Phase 1A field investigation for future analysis or consideration. As described in the SAP (Appendix A) and the Drilling and Sampling of Subsurface Materials SOP (Appendix B), soil samples from some newly-completed borings will be collected and archived for potential future evaluation. Any sample volume not consumed during sample analysis will be disposed of by the laboratories as described in the laboratory QAP and SOP (Appendix E), and in accordance with all applicable rules and regulations.

B.4 ANALYTICAL METHODS REQUIREMENTS

B.4.1 Purpose/Background

This section describes the analytical methods to be used to provide data necessary to meet the project objectives.

B.4.2 Subsampling

Samples collected during the Phase 1A field investigation will consist of both grab and composite samples. URSG will not collect any split samples for concurrent analysis by a second URSG laboratory for QA purposes. Upon request, and when sample containers are provided, URSG will collect split samples for another agency or interested group in instances where ample sample volume is available and aquifer or stream recharge is not limiting. Groundwater, surface water and sediment samples will not be archived for chemical or radiochemical analysis. Sediment samples will be homogenized in the field prior to collection into sampling containers and again at the laboratory prior to removal of a sample aliquot for preparation or analysis.

B.4.3 Preparation of Samples

Samples will be prepared as described in the Sample Handling, Shipment and Documentation SOP. Samples for dissolved metals will be filtered prior to preservation in the field using a hand

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or peristaltic pump and 0.45 micron filter. The filter and filter unit will be rinsed with approximately 25 – 50 ml of sample before collection for chemical analysis. Filtered samples will be immediately preserved. Groundwater and surface water samples will be sent for analysis of both total and dissolved metals.

Analytical parameters, sample quantities, types and numbers of containers, number and types of QA/QC samples, sample preservatives, and sample holding times are listed in Table B.4.3-1. The laboratories used to complete the analyses summarized in Section B.4.4 have not yet been identified. The technical Scopes Of Work (SOWs) for analytical work that is subcontracted to laboratories will be included as Appendix D at a later date when those SOWs are completed.

Should non-EPA laboratories and laboratories outside the EPA Contract Laboratory Program be contracted to complete analytical work, these laboratories should:

- have the ability to accept radioactive material;
- demonstrate successful participation in nationally recognized QA programs such as the Water Supply (WS) and Water Pollution (WP) Performance Evaluation Sample Program, if applicable; and
- have the ability to complete the required QA/QC elements outlined in this QAPP.

Additionally, laboratories completing radiological parameters should:

- possess an appropriate Nuclear Regulatory Commission and/or state radioactive materials license, or be federally exempt from being required to possess such a license for the radionuclides listed in Tables B.4.4-2f, B.4.4.3a, B.4.4-3b, and B.4.4-3c,
- demonstrate successful participation in nationally recognized QA programs such as the Quality Assurance Program for the Department of Energy; or the December 1998 discontinued EPA/Las Vegas Intercomparison Program for Groundwater; and
- have the ability to complete the required QA/QC elements outlined in this QAPP.

B.4.4 Analytical Methods

Table B.4.3-1 summarizes the analyses that will be completed during this investigation. All definitive methods and some screening methods will be conducted at an analytical laboratory. (Refer to Section A.7.4 for a discussion of analytical data quality levels.) The following screening methods will be performed in the field at the time of sampling: pH, temperature, specific conductance, Eh, turbidity, dissolved oxygen, and ferrous iron. These measurements will be taken at the sampling location using portable field instruments at the time of sample collection. Calibrations, QC checks, frequency of QC checks, acceptance criteria, and corrective actions for the field parameters and all other screening methods is summarized in Table B.4.4-1. A discussion of field instrument calibrations and QC checks is also included in SOP No. 7 Field Parameter Measurements. All field instrument calibration, QC check, and corrective action information will be recorded in a field log book. For all definitive methods of analysis used

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during this investigation, method performance requirements are specified in the methods, and augmented by this QAPP.

Tables B.4.4-2a through B.4.4-2g summarize the QC acceptance criteria including the required detection limit or quantitation limit and accuracy and precision requirements for each analyte of interest in each analysis with the exception of the decay series analyses. Tables B.4.4-3a through B.4.4-3c summarize the QC acceptance criteria including the required lower limit of detection, the counting error goal and the precision requirements for each analyte of interest in each of the three decay series analyses.

Desired detection limits should be attained when analyzing clean samples. However, sample dilutions may be necessary to bring high-level analyte concentrations into an accepted calibration range. Detection limits for non-detected analytes within those samples will be raised according to the level of the necessary dilution. Additionally, for a given method, intra-element interference and/or matrix effects may preclude the attainment of the desired detection limits listed in Tables B.4.4-2a through B.4.4-2g and B.4.4-3a through B.4.4-3c. Consequently, while the limits of detection and quantitation listed in Tables B.4.4-2a through B.4.4-2g and B.4.4-3a through B.4.4-3c are the true analytical goal, they may not be attained for all samples.

Radioanalytical results will be for only selected radionuclides in the three naturally-occurring decay series of interest, principally due to technical limitations in the measurement of activity concentrations of relatively short half-lived radionuclides (Tables B.4.4-3a, B.4.4-3b, and B.4.4-3c). This is especially true regarding non-gamma-emitting radionuclides in aqueous solutions. However, activity concentrations for radionuclides *not* measured may still be necessary input data for risk assessment purposes, in the cases where subchains of the naturally-occurring decay series are not in radiological equilibrium. Where such data are required, those data will be estimated from the radionuclide activity concentrations that are empirically determined by the analytical laboratory.

All sediment sample results will be reported on a dry-weight basis. However, laboratories will also report the percent solids for each sediment sample analyzed. The end use of the data may be either a wet-weight basis or a dry-weight basis depending on the criteria to be satisfied.

The turn around time for sample analysis and data reporting will be determined based on the laboratories selected and the project schedule once a field investigation start date has been established. Laboratory-required turn around times will be defined in the laboratory technical scopes of work.

The analytical laboratories will be required to submit case narratives with each analytical data package. The case narrative must document out-of-control events. In addition, any out-of-control occurrence must be reported to the Project QA Manager or designee as soon as possible so that the Project QA Manager can assess the out-of-control event and determine the appropriate course of action based on the overall project objectives, critical nature of the data, and project schedule. At a minimum, the laboratory will report the types of out-of-control occurrences, how these occurrences are documented, and who is responsible for correction and documentation. Corrective action will be taken at any time during the analytical process when deemed necessary

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based on analytical judgment or when QC data indicate a need for action. Laboratory corrective actions may include, but are not limited to:

- Reanalysis,
- calculation checks,
- instrument recalibration,
- preparation of new standards/blanks,
- re-extraction/digestion, and
- additional training of analysts.

The following items must be documented for out-of-control incidents so that corrective action may be taken to set the system back “in control.” These items will constitute a corrective action report and will be signed by the laboratory director and the laboratory QA contact:

- where the out-of-control incident occurred,
- when the incident occurred and was corrected,
- who discovered the out-of-control incident,
- who verified the incident,
- the scope of the problem,
- the corrective action implemented, and
- who corrected the problem.

B.5 QUALITY CONTROL REQUIREMENTS

B.5.1 Purpose/Background

QC requirements relevant to analysis of environmental samples shall be followed during analytical activities to meet the quality objectives and criteria for measurement data described in Section A.7. The purpose of this QC program is to produce data of known quality that satisfy the project objectives and that meet or exceed the requirements of the standard methods of analysis.

B.5.2 QC Procedures

QC procedures used to monitor and assure data quality are presented throughout this QAPP and listed in this section. The sampling process design and sampling methods requirements are discussed in Section B.1 and Section B.2 respectively. Sample handling and custody requirements are discussed in Section B.3. Analytical methods requirements are defined in Section B.4, which includes the use of QC samples as a mechanism (data quality indicator) for ongoing control and evaluation of data quality measurements. Data quality indicators are

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presented in Section A.7 and Section D.3. Method-specific acceptance criteria for the data quality indicators are listed in Section B.4 and Tables B.4.4-2a through B.4.4-2g and Tables B.4.4-3a through B.4.4-3c. QC procedures used to assess data quality include the assessment of QC samples, a comparison of total and dissolved metals concentrations, a cation-anion balance, and a reconciliation of data quality with end-use objectives.

B.5.2.1 QC Samples

A number of QC samples will be employed to assess various data quality parameters, such as representativeness of the environmental samples, the precision of sample collection and handling procedures, the thoroughness of the field equipment decontamination procedures, and the accuracy of laboratory analysis.

Laboratory QC samples (e.g., blanks and laboratory control samples) shall be included in the preparation batch with the field samples as applicable for each given method. An analytical batch is a number of samples (not to exceed 20 environmental samples) that are similar in composition (matrix) and that are extracted or digested at the same time and with the same lot of reagents. The term analytical batch also extends to cover samples that do not need separate extraction or digestion (e.g., volatile analyses by purge and trap). This analytical batch is a number of samples (not to exceed 20 environmental samples) that are similar in composition (matrix) and analyzed sequentially. The identity of each analytical batch shall be unambiguously reported with the analyses so that a reviewer can identify the QC samples and the associated environmental samples.

Additional QC checks for the analytical methods are specified in the methods and will be followed. The additional checks may include initial calibration, continuing calibration checks, calibration blanks, post digestion spikes, and dilution tests. The acceptance criteria for each of these checks are specified in the method. Corrective actions will be considered acceptable if subsequent QC checks indicate the laboratory analytical method is in control.

A summary of calibration and QC samples for screening methods is included in Table B.4.4-1. Included in Table B.4.4-1 is a listing of acceptance criteria and corrective actions for all screening methods including those analyses completed in the field.

Types of QC samples are discussed below and the number of these samples is discussed in Section B.4 and Table B.4.3-1.

B.5.2.1.1 Laboratory Control Sample

The laboratory control sample (LCS) is analyte-free water or solid spiked with all analytes or a subset of analytes listed in the QC acceptance criteria table in Section B.4 for the method. The spike concentrations will be documented in the appropriate laboratory SOPs or QAP (Appendix E). All spiking solutions must be traceable to the National Institute of Standards and Technology, EPA, or American Association of Laboratory Accreditation.

The LCS shall be carried through the complete sample preparation and analysis procedure. The LCS is used to evaluate each analytical batch and to determine if the method is in control. The

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LCS cannot be used as the continuing calibration verification. An LCS shall be included at the frequency specified in each method. The performance of the LCS is evaluated against the QC acceptance limits given in the tables in Section B.4.

Whenever an analyte in an LCS is outside the acceptance limit, method-specified corrective action shall be performed. After the system problems have been resolved and system control has been reestablished, all samples in the analytical batch shall be reanalyzed for the out-of-control analyte(s).

B.5.2.1.2 Matrix Spike/Matrix Spike Duplicate

A matrix spike (MS) and matrix spike duplicate (MSD) is an aliquot of sample spiked with known concentrations of all analytes or a subset of analytes listed in the QC acceptance criteria tables in Section B.4 for the method. The spiking occurs prior to sample preparation and analysis. The spike concentrations will be documented in the appropriate laboratory SOPs or QAP (Appendix E). All spiking solutions must be traceable to the National Institute of Standards and Technology, EPA, or American Association of Laboratory Accreditation.

The MS/MSD shall be designated on the chain of custody. The MS/MSD is used to document the bias of a method due to sample matrix. Consequently, MSs and MSDs are not used to control the analytical process. A minimum of one MS and one MSD sample shall be analyzed for every 20 environmental samples of a given matrix. The performance of the MS and MSD is evaluated against the QC acceptance limits given in the tables in Section B.4.

B.5.2.1.3 Surrogates

Surrogates (sometimes referred to as system monitoring compounds) are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but that are not normally found in environmental samples. Surrogates are used to evaluate accuracy, method performance, and extraction efficiency. Surrogates shall be added to environmental samples, controls, and blanks, in accordance with the method requirements.

Whenever a surrogate recovery is outside the acceptance limit, method-specified corrective action must be performed. After any system problems have been resolved and system control has been reestablished, reprep and reanalyze the sample.

B.5.2.1.4 Internal Standards

Internal standards (ISs) are measured amounts of certain compounds added after preparation or extraction of a sample. ISs shall be added to environmental samples, controls, and blanks, in accordance with the method requirements.

When the IS results are outside of the acceptance limits, method-specified corrective actions shall be performed. After any system problems have been resolved and system control has been reestablished, all samples analyzed while the system was malfunctioning shall be reanalyzed.

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B.5.2.1.5 Interference Check Sample

The interference check sample (ICS), used in inductively coupled plasma (ICP) analyses only, contains both interfering and analyte elements of known concentrations. The ICS is used to verify background and interelement correction factors and is run at the beginning and end of each run sequence.

When the interference check sample results are outside of the acceptance limits stated in the method, corrective action shall be performed. After any system problems have been resolved and system control has been reestablished, reanalyze the ICS. If the ICS result is acceptable, reanalyze all affected samples.

B.5.2.1.6 Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank shall be carried through the complete sample preparation and analytical procedure and is used to document contamination resulting from the analytical process. A method blank shall be included in every analytical batch.

The presence of analytes in a method blank at concentrations equal to or greater than the method-specified thresholds indicates a need for corrective action. Corrective action shall be performed to eliminate the source of contamination prior to proceeding with analysis. After the source of contamination has been eliminated, all samples in the analytical batch shall be reprepared and reanalyzed. No analytical data shall be corrected for the presence of analytes in blanks.

B.5.2.1.7 Ambient Blank

The ambient blank consists of ASTM Type II reagent grade water poured into a volatile organic compound (VOC) sample vial at the sampling site (in the same vicinity as the associated samples). It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC or TVPH samples are taken and are analyzed only for VOC or TVPH analytes.

Ambient blanks are used to assess the potential introduction of contaminants from ambient sources (e.g., active runways, engine test cells, gasoline motors in operation, etc.) to the samples during sample collection. The frequency of collection for ambient blanks shall be a minimum of one ambient blank for every 20 environmental samples. Ambient blanks shall be collected at or near a sample location and if possible, downwind of possible VOC sources.

B.5.2.1.8 Equipment Blank

An equipment blank is a sample of reagent grade water poured into or over or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis. Equipment blanks are used to assess the effectiveness of equipment decontamination procedures used to prevent cross-contamination between sampling locations. The frequency of collection for equipment blanks shall be a minimum of 1 equipment blank for every 20 environmental samples collected with a given type of sampling equipment, and only for

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sampling equipment which is decontaminated and reused to collect environmental samples. Equipment blanks will be prepared in a manner identical to samples and shall be analyzed for all laboratory analyses requested for the environmental samples collected at the site using the subject equipment.

B.5.2.1.9 Trip Blank

The trip blank consists of a VOC sample vial filled in the laboratory with American Society of Testing and Materials (ASTM) Type II reagent grade water, transported to the sampling site, handled like an environmental sample and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes. Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures. One trip blank shall accompany each cooler of samples sent to the laboratory for analysis of VOCs.

B.5.2.1.10 Field Duplicates

A field duplicate sample is a second discrete sample volume collected at the same location as the original sample; homogenization is not performed between the original sample and the field duplicate. Aqueous field duplicate samples are collected from successive volumes from the same sample source and device (e.g., bailers). Sediment field duplicates are collected in succession from the same sample source and device. Duplicate samples are collected using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Field duplicate sample results are used to assess precision of the sample collection process. The frequency of collection for field duplicates is a minimum of 1 duplicate sample from each group of 20 environmental samples of a given matrix.

B.5.2.2 Comparison of Total and Dissolved Metals Concentrations

As another QC check of data quality, groundwater and surface water samples for which both total and dissolved metal concentrations are reported, will be evaluated to determine if dissolved concentrations exceed total concentrations. Generally, dissolved metal concentrations will be less than the respective total metal concentrations. However, as a result of accepted error (expressed as accuracy limits) and the reporting of very low concentrations of metals, some dissolved metal concentrations may exceed total metal concentrations. If dissolved metal concentrations exceed total metal concentrations, the laboratory may be requested to re-digest and/or reanalyze the subject samples. Refer to Section D.4 for the quantitative assessment of dissolved and total metal concentrations.

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B.5.2.3 Cation-Anion Balance

As another QC check of data quality, groundwater and surface water samples for which both cation and anion concentrations are reported, will be evaluated to determine the cation-anion balance. Concentrations of dissolved major cations (calcium, magnesium, sodium, potassium, and others as appropriate) and total ammonia will be compared to concentrations of major anions (sulfate, chloride, carbonate, bicarbonate, and others as appropriate). If the cation-anion ratio does not balance, the laboratory may be requested to re-digest (cations) and/or reanalyze the subject samples. Refer to Section D.4 for the quantitative assessment of cation-anion balance.

B.5.2.4 Reconciliation of Data with Quality Objectives

Section D.3 describes the process by which data quality indicators (presented in Section A.7) are reconciled against the method-specific acceptance criteria listed in Section B.4 and Tables B.4.4-2a through B.4.4-2g and Tables B.4.4-3a through B.4.4-3c.

B.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

B.6.1 Purpose/Background

The following section discusses procedures used to verify that all instruments and equipment are maintained in sound operating condition and are capable of operating at acceptable performance levels.

B.6.2 Testing, Inspection, and Maintenance

Testing, inspection and preventative maintenance activities will be carried out on both field and laboratory equipment through regularly scheduled maintenance checks.

B.6.2.1 Field Equipment

Field equipment that will be used during this investigation is listed in the SAP (Appendix A). Equipment will receive routine maintenance checks in order to minimize equipment breakdowns in the field. The maintenance of the equipment will be performed in accordance with manufacturer operation manuals and documented in maintenance logbooks. Daily inspections for visible signs of wear or breakage will be performed. If a piece of equipment is unusable due to breakage, it will be repaired if possible, removed from service, or replaced. Instruments such as the pH/conductivity/temperature/turbidity meter(s) will also be checked daily for proper operation using calibration standards or standard reference materials. Frequency of calibration for field equipment is described in Section B.4, while calibration procedures are discussed in Section B.7. Decontamination of all equipment will be completed as described in the SAP (Appendix A).

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B.6.2.2 Laboratory Equipment

As part of its QA/QC program, a routine preventative maintenance program will be conducted by the laboratory to minimize the occurrence of instrument failure and other system malfunctions. Guidelines for inspection and preventive maintenance of equipment will be established in the laboratory QAP/SOP(s), which will be included as Appendix E to this QAPP at a later date. Essentially, inspection and preventive maintenance will be implemented on a scheduled basis to minimize downtime and to assure accurate measurements from laboratory equipment. This program is designed to achieve results commensurate with the specified capabilities of equipment operation, thus generating data of known quality without concern for misapplication. In addition, back-up equipment and critical spare parts will be maintained to quickly correct equipment malfunction, and emergency repair or scheduled manufacturer maintenance may be provided under a repair and maintenance contract with factory representatives.

All equipment and instruments used to generate data will be adjusted and maintained to operate within manufacturers' specifications and the method requirements. Maintaining the necessary accuracy, precision, sensitivity, and traceability of the equipment helps assure that reliable measurements and representative data will be obtained. Methods and intervals of inspection and maintenance will be based on the type of equipment; stability characteristics; required accuracy; intended use; and environmental factors (such as temperature, humidity, etc.). Such an effort will be conducted by trained technicians using service manuals or through service agreements with a qualified maintenance contractor. In addition, procedures will assure that equipment is properly used by trained personnel.

As appropriate, inspection, maintenance, schedules, and records will be maintained for the equipment. Both equipment and equipment records will be located in a controlled access facility. Equipment that is identified as malfunctioning will be removed from operation until repaired. After repair and before use, the instrument shall be re-inspected and the laboratory must demonstrate that the instrument is back in working order. This may be accomplished by meeting the prescribed method and QAPP QC protocol such as sensitivity checks, calibrations, and QC standards using reference materials such as the National Institute of Standards and Technology's Standard Reference Materials. Adequate documentation must be maintained by the laboratory to demonstrate that instruments and equipment are operating within method-required criteria.

B.7 INSTRUMENT CALIBRATION AND FREQUENCY

B.7.1 Purpose/Background

Calibration procedures used for instrumental analytical methods used in environmental measurements are described in this section.

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B.7.2 Identification of Instrumentation Requiring Calibration

Instrumentation requiring calibration is divided into field equipment and laboratory equipment, each described below.

B.7.2.1 Field Equipment

As previously stated in Section B.6, field equipment that will be used during this investigation is listed in the SAP (Appendix A). Field equipment will be calibrated according to the manufacturers' recommendations as described in the equipment manual. Equipment that fails calibration or becomes inoperable during use will be removed from service and segregated to prevent inadvertent use. Such equipment will be repaired and satisfactorily recalibrated prior to reuse. Equipment that can not be repaired will be replaced.

Those field instruments requiring calibration and the frequency and make-up of that calibration are listed in Table B.4.4-1. Field instruments requiring calibration will be calibrated using traceable standards, as available. Any flow measurement cup used during well purging will be "calibrated" only once and will be marked with gradations by pouring a known amount of water into the cup and marking the fluid level on the side of the cup. Several volumes will be added and marked as appropriate. Calibration and calibration checks are summarized in Table B.4.4-1.

B.7.2.2 Laboratory Equipment

Instruments required to perform the analytical methods listed in the Section B.4 tables are defined within those methods. All instruments will be calibrated in accordance with the method with regard to frequency and rigor. Instruments that fail calibration will be removed from service. Such instrumentation will be repaired and satisfactorily recalibrated prior to reuse. All analytes reported will be present in the initial and continuing calibrations, and all calibrations will meet the acceptance criteria specified in the method, at a minimum. All results reported will be within the calibrated range.

The initial calibration will be checked at the frequency specified in the method using standard materials. Multi-point calibrations will contain the minimum number of calibration points specified in the method, with all points used for the calibration being contiguous. If more than the minimum number of standards is analyzed for the initial calibration, all of the standards analyzed will be included in the initial calibration.

B.7.3 Documentation of Instrument Calibrations

Instrument calibrations will be documented to include at a minimum, identification of the instrument calibrated, the date and time of calibration, the analytes and concentrations of those analytes included in the calibration mix, and traceability of the calibration standard to a reference solution. Records of instrument calibration will be maintained and submitted with the final data package.

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B.7.4 Documentation of Calibration Standards

Records of standards used to calibrate field instruments will be retained in the project file. Records of standards preparation and/or dilutions completed by laboratories will be maintained and submitted with the final data package as appropriate for each method. Calibrations will be completed using certified equipment and/or standards with known and demonstrated valid relationships to nationally-recognized performance standards. Standards must comply with method-specified holding time requirements. The preparation and use of all working standards must be recorded in bound laboratory notebooks that document standard traceability to U.S. EPA, A2LA or National Institute for Standards and Technology (NIST) criteria. Standards not obtainable under these programs must be approved prior to use.

B.8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

B.8.1 Purpose

The purpose of this element is to establish and document a system for inspecting and accepting all supplies and consumables that may directly or indirectly affect the quality of the project.

B.8.2 Identification of Supplies and Consumables

Supplies and consumables consist of field and laboratory supplies and consumables, each described below.

B.8.2.1 Field Supplies and Consumables

The consumables that will be used during field operations include decontamination fluids, water for rinsate blank preparation, tubing, and filters. No material will be used beyond the manufacturers' suggested expiration date. The decontamination fluids will be visually inspected for gross contamination and considered usable if no visible contamination is present. If contamination is visible, the item will be discarded and replaced. The water used for the preparation of the equipment blanks and ambient blanks will be reagent-grade water. Only water certified by the manufacturer will be used to prepare equipment and ambient blanks. If detections are reported for equipment or ambient blanks, any remaining water from the suspected lot will be discarded and replaced. Tubing and filters will be visually inspected for contamination, and only tubing and filters that are sealed in the original packaging will be used. Filters will not be reused or decontaminated. Tubing will be decontaminated as described in the SAP. If detections are reported in the equipment blanks, an effort will be made to determine the source of the contamination. If the contamination source is not discernable, decontamination procedures may be changed or the use of dedicated tubing instituted. The samples associated with a contaminated blank will be reviewed to determine if the potential contamination has affected the usability of the data. The data will be reviewed and determinations made on a case-by-case basis.

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B.8.2.2 Laboratory Supplies and Consumables

The laboratory will inspect supplies and consumables prior to their use in analysis. The materials description in the analytical methods will be used as a guideline for establishing acceptance criteria for those materials. Purity of reagents will be monitored through the analysis of blanks and an LCS. An inventory and storage system for all supplies and consumables will be established. The inventory system will be documented in the laboratory QAP (Appendix E). No material will be used beyond the manufacturers' suggested expiration date.

B.8.3 Inspection Requirements and Procedures

Maintenance of inventory, inspections and acceptance of the field supplies and consumables is the responsibility of the Field Investigation Site Manager. Maintenance of inventory, inspections and acceptance of the laboratory supplies and consumables will be completed as specified in the laboratory QAP.

B.8.4 Tracking and Quality Verification of Supplies and Consumables

Supplies and consumables requiring a degree of purity and received from vendors specifying the degree of purity will have the vendor specifications retained in the project file for field consumables and retained by the laboratory for laboratory consumables.

It is the responsibility of the Field Investigation Site Manager to ensure that field supplies and consumables that do not meet specification, have expired, or do not meet acceptance criteria are not used for the project.

B.9 DATA ACQUISITION REQUIREMENTS (NON-DIRECT MEASUREMENTS)

Substantial amounts of historic analytical chemistry data have been collected for groundwater, surface water, and sediments in the PIA, particularly to the south of the MA. Data has been collected by Dawn Mining Company (DMC), the USGS, the EPA (1998 Expanded Site Investigation), the Upper Columbia United Tribes Fishery Center (UCUTFC), and most recently, by Shephard Miller, Inc. (SMI) as a contractor to DMC. The quality of these data varies widely. Much of the data collected before 1998 by DMC and that by the UCUTFC is of unknown quality. Problems with these data include unavailable or inadequate documentation of well construction or sampling procedures, unacceptable field data collection procedures or documentation, failure to meet laboratory QA/QC requirements, and lack of data validation. Data collected by the USGS in 1991 and 1996 were analyzed at the USGS laboratories and were not validated per EPA procedures. These data also lack documentation of chain-of-custody and laboratory QA/QC procedures. Therefore, data collected by DMC, the USGS, and the UCUTFC are not of sufficient quality to be used for a quantitative risk assessment, although they are still useful for qualitative evaluation of nature and extent of contamination in the Midnite Mine RI/FS.

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Samples collected by the EPA (1998 Expanded Site Investigation) are well documented. Target Analyte List inorganic analyses were performed under EPA's Contract Laboratory Program (CLP) protocols. The radiochemistry was performed by a commercial laboratory using methods approved by EPA Region 10 quality assurance staff. Data from the CLP laboratory were validated by EPA according to the procedures contained in USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 1994b) and commercial laboratory data were validated by E&E and are considered to be usable for all purposes.

SMI is currently collecting groundwater, surface water, and sediment data on a quarterly basis in both the MA and PIA. These data are collected under well documented sampling procedures and analyzed by EPA analytical methods. SMI laboratory results undergo a data validation procedure that consists of checking holding times, precision of field duplicates and blanks, cation-anion balances, and the agreement between total versus dissolved concentrations. Data validation using guidance from the Functional Guidelines (EPA 1994b) and Section D of this QAPP will be performed on these data prior to using these data quantitatively in the risk assessment. It is expected that the SMI data may be usable for all purposes.

B.10 DATA MANAGEMENT

B.10.1 Purpose/Background

Data reduction, verification, and reporting procedures and project data management activities, data/information exchange, and reporting procedures must ensure that complete documentation is maintained, transcription and reporting errors are minimized, and all data including that form received from laboratories are properly reviewed.

B.10.2 Data Recording

Internal checks used to assure data quality during data entry are discussed in Section B.10.5. Internal checks used to assure the quality of data resulting from calculations is discussed in Section B.10.4.

B.10.3 Data Validation

The assurance that the method, instrument, or system performs the function it is intended to consistently, reliably, and accurately in generating the data is achieved through the validation and verification of analytical data as discussed in Section D.

B.10.4 Data Transformation

The conversion of data points using formulae, data transformations and calculations will be checked to verify the correctness of the result. Laboratory data transformation will be completed

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in accordance with the laboratory SOP (Appendix E). Computer/software data transformation is discussed in Sections B.10.6 and B.10.7.

All URSG calculations will be recorded on calculation sheets and will be legible and in logical progression with sufficient descriptions. Major calculations will be checked by an engineer or scientist of professional level equal to or higher than that of the originator. After ensuring mistakes have been corrected, the checker will sign and date the calculation sheet immediately below the originator. Both the originator and checker are responsible for the correctness of calculations. The following information will be recorded for each calculation or a series of calculations, as applicable:

- project title and brief description of the task;
- task number, date performed, and signature of person who performed the calculation;
- basis for calculation;
- assumptions made or inherent in the calculation;
- complete reference for each source of input data;
- methods used for calculations, including reference;
- results of calculations, clearly annotated;
- problem statement;
- input data clearly identified; and
- variables listed.

B.10.5 Data Transmittal

All data that are manually entered from logbooks or field forms into a computer file will be verified after data entry for correctness. Similarly, all data that are transcribed from one logbook or field form to another will be verified after data transcription for correctness. Data received electronically will be reviewed for obvious signs of corruption and information loss prior to use. Analytical data are usually received electronically from subcontracting laboratories. Specific data fields and file formats must be established and tested prior to data delivery to assure that the formats are compatible with the project database and all required information is reported in compliance with project requirements. Analytical data received electronically from a laboratory should be compared (at a minimum frequency of 10%) with the laboratory hard copy reports to verify correct data transfer. If systematic discrepancies or an unacceptably high rate of random errors are found, the frequency must be increased to assure that all information has been correctly added. The level of review completed should be documented and corrective actions must be identified and implemented if systematic or high random error rates occur.

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B.10.6 Data Reduction

This section outlines the methodology for assuring the correctness of the data reduction process.

B.10.6.1 Non-Laboratory Data Reduction

The procedures describe steps for verifying the accuracy of data reduction. Data will be reduced either manually on calculation sheets or by computer on formatted printouts. The following responsibilities will be delegated in the data reduction process:

- Technical personnel will document and review their own work and are accountable for its correctness.
- Major calculations will receive both a method and an arithmetic check by an independent checker. The checker will be accountable for the correctness of the checking process.
- A Peer Review scheduled by the URSG Project Manager will be conducted to assure the consistency and defensibility of the concepts, methods, assumptions, calculations, etc.
- The URSG Project Manager will be responsible for assuring that data reduction is performed in a manner that produces quality data through review and approval of calculations.

As data are reduced, care must be taken so that critical data (e.g., significant figures) are not lost.

B.10.6.2 Laboratory Data Reduction

The specific data reduction, verification, and reporting procedures and assigned personnel vary between laboratories; however, equivalent procedures must be performed by each laboratory to assure that accurate and consistent data handling, review, and reporting are achieved.

Laboratory-specific procedures are evaluated during technical systems audits to assure that the process steps described here are properly performed.

The laboratory analyst performing analyses is responsible for the reduction of raw data generated at the laboratory bench to calculate sample concentrations. The data reduction procedures are described in the laboratory's method SOPs (Appendix E). For many methods, data reduction software is included with the instrument or Laboratory Information Management System (LIMS). In those cases, the analyst must verify that the data reduction was correct. The system may require manual manipulation to correctly calculate sample concentrations.

The analytical process includes verification or a quality assurance (QA) review of the data. Specific requirements, acceptance criteria, and corrective actions for each analysis are included in the analytical method. The QC checks are reviewed at several levels by laboratory analysts, supervisors, designated QC specialists, document control staff, or by a combination of these staff. After the data have been reviewed and verified, the laboratory reports are signed and released for distribution.

Most laboratories use a LIMS to electronically track and report sample and QC data. The data are reported electronically from the LIMS to the project staff using pre-established formats. The

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LIMS files must also undergo a QC check to verify that the results are complete and correct, and that the files are properly formatted.

B.10.7 Data Analysis

Computer analyses include the use of models and programs. Both systematic and random error analyses will be investigated and appropriate corrective action measures taken. The URSG project manager will evaluate, determine applicability, and document the use of automated data reduction techniques if needed on this project.

For in-house programs developed specifically for this project, the URSG project manager will review documentation prior to use. This documentation will be prepared in accordance with computer program verification procedures and will contain at a minimum:

- Description of methodology, engineering basis, and major mathematical operations,
- Flow chart presenting the organization of the program, if appropriate, and
- Test case(s), sufficiently comprehensive to test all program operations.

QC procedures for checking models (or programs) will involve reviewing the documentation, running the test case, and manually checking selected mathematical operations. Each computer run used to check a model or program will have a unique number, date, and time associated with it appearing on the printout.

B.10.8 Data Tracking

Laboratory and field data must flow properly to the project staff and data users. Procedures must be established to ensure that data are properly reported and undergo QC review before use.

A data management plan should exist for each laboratory to be used and should be addressed in the laboratory QAP or SOPs. All electronic and hard copy data received from laboratories will be tracked for completeness of delivery and ultimately filed in the project data file. Care must be taken to ensure that all final laboratory data are received and documented.

All field measurements, lithologic data, and sample collection information will be recorded and filed in the field for use and reference before ultimately being filed into the project data file.

B.10.9 Data Storage and Retrieval

All data generated during this field investigation will be maintained in the project files located in the URSG office in Seattle, Washington. As soon as possible after generation, original hardcopy data will be placed in the project data files. If the information or data are needed for interpretation of results or report completion, copies will be used. Copies will be stamped as such to avoid multiple copies of the same document in the files. All field-generated data, such as field forms and logbooks, will be reviewed for completeness and legibility prior to incorporation in the data files. If corrections are needed, the document will be returned to the originator for correction. Laboratory data will be copied immediately upon receipt (or a second copy delivered

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by the laboratory) and the original placed in the data files. Information obtained from outside sources will be maintained in the project files only if the information is not publicly available. For instance, documents used as guidance (e.g., EPA QA/R-5) will not be maintained in the project files. Historical information specific to the site may also be maintained in the project files.

A document control system is used to uniquely identify Work Assignment deliverable documents contained in the project files. The document control system incorporates the URSG project number, the file code, and a unique number assigned to each document. At the time of Work Assignment closeout, all project file originals will be turned over to EPA.

Electronic data and electronically generated reports and data interpretations will be stored on the Seattle office network. The network is backed up daily and weekly to avoid data loss. Retrieval of documents may be limited to personnel who have been granted access to the appropriate network drive. Sensitive or final electronic documents may become password protected to prevent inadvertent changes. Electronic laboratory data will be copied to the Seattle office network prior to incorporation into any databases to maintain an original copy. Electronic project correspondence may be printed, and a hardcopy may be maintained in the central files. It is the URSG Project Manager's responsibility to assure that project personnel comply with this requirement. At project or Work Assignment closure, these electronic documents may be copied onto disks or CD-ROM and, if requested, delivered to EPA; one copy may be archived by URSG.

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Table B.4.3-1
QC SAMPLE SUMMARY AND SAMPLE CONTAINERS AND PRESERVATIVES

Analytical Parameter	Analytical Method (f)	Definitive or Screening Method (c)	Sample Matrix	Estimated Number of Field Samples (b)	Estimated Number of LAB QC Samples (b)		Estimated Number of FIELD QC Samples (b)					Preservation	Number/ Minimum Volume of Container(s) (j)	Sample Hold Time (from collection)
					MS	MSD or DUP	Field Dup	Trip Blank	Ambient Blank	Equip. Blank (d)	PE (g)			
VOC	OLC02.0	Definitive	Water	12	1	1	1	1	1	1	1	pH < 2 with HCl	2 40-ml VOA vials	14 days
TVPH	SW-846 8015B	Definitive	Water	36	2	2	2	2	2	2	1	pH < 2 with HCl	2 40-ml VOA vials	14 days
SVOC	OLC02.0	Definitive	Water	15	1	1	1	0	0	1	1	Cool to 4 °C	2 1-liter amber glass	7 days until extraction; 40 days after extraction
SVOC	OLM03.0	Definitive	Sediment	4	1	1	1	0	0	1	1	Cool to 4 °C	1 16-oz glass	14 days until extraction; 40 days after extraction
TEPH	SW-846 8015B	Definitive	Water	50	3	3	3	0	0	3	1	Cool to 4 °C	2 1-liter amber glass	7 days until extraction; 40 days after extraction
TEPH	SW-846 8015B	Definitive	Sediment	17	1	1	1	0	0	1	1	Cool to 4 °C	1 16-oz glass	14 days until extraction; 40 days after extraction
Total Metals	ILM04.0 and SW-846 6020B	Definitive	Water	108	6	6	6	0	0	6	1	pH < 2 with HNO ₃	1 1-liter poly	180 days
Metals	ILM04.0	Definitive	Sediment	68	4	4	4	0	0	4	1	Cool to 4 °C	1 16-oz poly or glass	180 days
Total Mercury	ILM04.0	Definitive	Water	108	6	6	6	0	0	6	1	pH < 2 with HNO ₃	1 500-ml poly	28 days
Mercury	ILM04.0	Definitive	Sediment	68	4	4	4	0	0	4	1	Cool to 4 °C	1 16-oz poly or glass	28 days

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QC SAMPLE SUMMARY AND SAMPLE CONTAINERS AND PRESERVATIVES

Analytical Parameter	Analytical Method (f)	Definitive or Screening Method (c)	Sample Matrix	Estimated Number of Field Samples (b)	Estimated Number of LAB QC Samples (b)		Estimated Number of FIELD QC Samples (b)					Preservation	Number/ Minimum Volume of Container(s) (j)	Sample Hold Time (from collection)
					MS	MSD or DUP	Field Dup	Trip Blank	Ambient Blank	Equip. Blank (d)	PE (g)			
Diss. Metals	ILM04.0 and SW-846 6020B	Definitive	Water	108	6	6	6	0	0	6	0	pH < 2 with HNO ₃	1 1-liter poly	180 days
Diss. Mercury	ILM04.0	Definitive	Water	108	6	6	6	0	0	6	0	pH < 2 with HNO ₃	1 500-ml poly	28 days
Ammonia	EPA 350.1	Definitive	Water	108	6	6	6	0	0	6	1	2 ml of H ₂ SO ₄ for every liter and Cool to 4 °C	1 500-ml poly	28 days
Ammonia	EPA 350.1	Definitive	Sediment	68	4	4	4	0	0	4	1	Cool to 4 °C	1 16-oz glass	28 days
Anions	SW-846 9056 or EPA 300.0	Definitive	Water	108	6	6	6	0	0	6	1	Cool to 4°C	1 250-ml poly	48 hours for NO ₂ , 28 days for all else
Anions	SW-846 9056 or EPA 300.0	Definitive	Sediment	68	4	4	4	0	0	4	1	Cool to 4°C	1 16-oz glass	28 days
Carbonate, Bicarbonate	Std. Methods 2320B	Screening	Sediment	68	4	4	4	0	0	4	0	Cool to 4 °C	1 250-ml poly	14 days
pH	SW-846 9040B	Screening	Water	108	0	6	0	0	0	0	0	NA	Poly or glass	Analyze Immediately
pH	SW-846 9045C	Screening	Sediment	68	0	4	0	0	0	0	0	Cool to 4 °C	1 4 oz. Poly or glass	Analyze as soon as possible following receipt at laboratory
Temperature	EPA 170.1	Screening	Water	108	0	6	0	0	0	0	0	NA	Poly or glass	Analyze Immediately
Specific Conductance	EPA 120.1	Screening	Water	108	0	6	0	0	0	0	0	NA	Poly or glass	Analyze Immediately

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Table B.4.3-1
QC SAMPLE SUMMARY AND SAMPLE CONTAINERS AND PRESERVATIVES

Analytical Parameter	Analytical Method (f)	Definitive or Screening Method (c)	Sample Matrix	Estimated Number of Field Samples (b)	Estimated Number of LAB QC Samples (b)		Estimated Number of FIELD QC Samples (b)					Preservation	Number/ Minimum Volume of Container(s) (j)	Sample Hold Time (from collection)
					MS	MSD or DUP	Field Dup	Trip Blank	Ambient Blank	Equip. Blank (d)	PE (g)			
Eh	ASTM 1498	Screening	Water	108	0	6	0	0	0	0	0	NA	Poly or glass	Analyze Immediately
Turbidity	EPA 180.1	Screening	Water	108	0	6	0	0	0	0	0	NA	Poly or glass	Analyze Immediately
Dissolved Oxygen	EPA 360.1	Screening	Water	108	0	0	0	0	0	0	0	NA	Poly or glass	Analyze Immediately
Ferrous Iron	Mod. HACH #8146	Screening	Water	108	0	0	0	0	0	0	0	NA	Poly or glass	Analyze Immediately
TSS	EPA 160.2	Screening	Water	108	0	0	6	0	0	6	0	Cool to 4 °C	1 100-ml poly	7 days
TDS	EPA 160.1	Screening	Water	108	0	0	6	0	0	6	0	Cool to 4 °C	1 100-ml poly	7 days
TOC	AP-3086	Screening	Sediment	68	0	0	4	0	0	0	0	Cool to 4 °C	1 500-ml amber glass	28 days
Alkalinity	Std. Method 2320B	Screening	Water	108	6	6	6	0	0	6	0	Cool to 4 °C	1 250-ml poly	14 days
Hardness	Std. Method 2340 B	Screening	Water	108	0	0	6	0	0	6	0	NA	NA (calculated)	NA
Total Phosphorus and Ortho phosphate	EPA 365.1	Definitive	Water	45	3	3	3	0	0	3	0	2 ml of H ₂ SO ₄ for every liter and Cool to 4 °C	1 500-ml poly	28 days

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Table B.4.3-1
QC SAMPLE SUMMARY AND SAMPLE CONTAINERS AND PRESERVATIVES

Analytical Parameter	Analytical Method (f)	Definitive or Screening Method (c)	Sample Matrix	Estimated Number of Field Samples (b)	Estimated Number of LAB QC Samples (b)		Estimated Number of FIELD QC Samples (b)					Preservation	Number/ Minimum Volume of Container(s) (j)	Sample Hold Time (from collection)
					MS	MSD or DUP	Field Dup	Trip Blank	Ambient Blank	Equip. Blank (d)	PE (g)			
Total Phosphorus and Ortho phosphate	Std. Method 4500-P B.4 + 4500-PE (total) and EPA 365.1	Definitive	Sediment	68	4	4	4	0	0	4	0	Cool to 4 °C	1 16-oz glass	28 days
COD	EPA 410.4	Screening	Water	45	0	0	3	0	0	3	0	pH < 2 with H ₂ SO ₄ Cool to 4 °C	1 100-ml poly	28 days
Particle Size Distribution	ASTM D422-63	Screening	Sediment	68	0	4	0	0	0	0	0	None required	1 8-oz glass (k)	None
U-234, U-235, U-238	NAREL U/Th-01	Definitive	Water	108	6 (a)	6 (a)	6	0	0	6	1	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
U-234, U-235, U-238	NAREL U/Th-01	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months
Th-230	NAREL U/Th-01	Definitive	Water	108	6 (a)	6 (a)	6	0	0	6	1	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Th-230	NAREL U/Th-01	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months
Th-228, Th-232	NAREL U/Th-01	Definitive	Water	108	6 (a)	6 (a)	6	0	0	6	1	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Th-228, Th-232	NAREL U/Th-01	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months
Ra-226	NAREL Ra-04	Definitive	Water	108	6 (a)	6 (a)	6	0	0	6	1	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Ra-226	NAREL Ra-01, Ra-04	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months

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Table B.4.3-1
QC SAMPLE SUMMARY AND SAMPLE CONTAINERS AND PRESERVATIVES

Analytical Parameter	Analytical Method (f)	Definitive or Screening Method (c)	Sample Matrix	Estimated Number of Field Samples (b)	Estimated Number of LAB QC Samples (b)		Estimated Number of FIELD QC Samples (b)					Preservation	Number/ Minimum Volume of Container(s) (j)	Sample Hold Time (from collection)
					MS	MSD or DUP	Field Dup	Trip Blank	Ambient Blank	Equip. Blank (d)	PE (g)			
Ra-228	NAREL Ra-05	Definitive	Water	108	6 (a)	6 (a)	6	0	0	6	1	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Ra-228	NAREL Ra-01, Ra-05	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months
Pa-231	Mod HASL 300	Definitive	Water	108	6 (a)	6 (a)	6	0	0	6	1	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Pa-231	Mod HASL 300	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months
Ac-227	Mod. HASL 300	Definitive	Water	108	0	6	6	0	0	6	0	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Ac-227	Mod. HASL 300	Definitive	Sediment	68	0	4	4	0	0	4	0	None	2 1-liter poly (i)	6 months
Rn-222	NAREL Gam-01	Definitive	Water	108	0	6	6	0	0	6	0	pH < 2 with HNO ₃	1 1-liter marinelli	4 days
Pb-210	Mod. HASL 300	Definitive	Water	108	6 (a)	6 (a)	6	0	0	6	1	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Pb-210	Mod. HASL 300	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months
Gross Alpha	NAREL Gr-01	Definitive	Water	108	0	6	6	0	0	6	0	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Gross Beta	NAREL Gr-01	Definitive	Water	108	0	6	6	0	0	6	0	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Th-232 Decay Series	Multiple (e)	Definitive	Water	36	2 (a)	2 (a)	2	0	0	2	0	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
Th-232 Decay Series	Multiple (e)	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months

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Table B.4.3-1
QC SAMPLE SUMMARY AND SAMPLE CONTAINERS AND PRESERVATIVES

Analytical Parameter	Analytical Method (f)	Definitive or Screening Method (c)	Sample Matrix	Estimated Number of Field Samples (b)	Estimated Number of LAB QC Samples (b)		Estimated Number of FIELD QC Samples (b)					Preservation	Number/ Minimum Volume of Container(s) (j)	Sample Hold Time (from collection)
					MS	MSD or DUP	Field Dup	Trip Blank	Ambient Blank	Equip. Blank (d)	PE (g)			
U-235 Decay Series	Multiple (e)	Definitive	Water	36	2 (a)	2 (a)	2	0	0	2	0	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
U-235 Decay Series	Multiple (e)	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months
U-238 Decay Series	Multiple (e)	Definitive	Water	36	2 (a)	2 (a)	2	0	0	2	0	pH < 2 with HNO ₃	3 1-gallon poly (h)	6 months
U-238 Decay Series	Multiple (e)	Definitive	Sediment	68	4 (a)	4 (a)	4	0	0	4	0	None	2 1-liter poly (i)	6 months

Table B.4.3-1 Footnotes:

- (a) As spiking standards are available and as appropriate for the contracted laboratory.
- (b) Sample quantities reflect the first event of sampling. Sample quantities and matrices for events 2 and 3 will be decided following completion of event 1 and review of resultant data.
- (c) All definitive methods and some screening methods will be conducted at an analytical laboratory. The following screening methods will be performed in the field at the time of sampling: pH (water only), temperature, specific conductance, Eh, turbidity, dissolved oxygen and ferrous iron.
- (d) Assumes no dedicated or disposable sampling equipment will be used and therefore, equipment blanks are necessary for groundwater, surface water and sediment samples.
- (e) Methods utilized to analyze the decay series constituents are summarized in tables B.4.4-3a, 3b and 3c.
- (f) Analysis completed using the listed method or more recent revision of the listed method. Refer to tables B.4.4-2a – B.4.4-2g and tables B.4.4-3a – B.4.4-3c for details of specific analytes and methods. Proposed/equivalent analytical methods may be used pending EPA approval.
- (g) As Performance Evaluation Samples are available and as appropriate for the contracted laboratory following review of the laboratory QAP, SOPs, recent audit reports, and recent PE sample performance.
- (h) Assuming all radiological parameters are sent for analysis to the same laboratory, an aggregate volume of 3 gallons of water will be used to complete all radiological parameters except radon. One in ten samples collected will have an aggregate volume of 5 gallons for laboratory QC (MS/MSD, method duplicate).
- (i) Assuming all radiological parameters are sent for analysis to the same laboratory, an aggregate volume of 2 liters of sediment with a sieve size less than 1/8 inch will be used to complete all radiological parameters.

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- (j) Parameters requiring the same preservation, similar container type and being analyzed by the same laboratory may be collected as one aggregate volume.
- (k) Collect an additional 8 oz volume for every tenth sample for laboratory QC.

Definitions for Table B.4.3-1:

OLC02.0:	USEPA CLP Program, Statement of Work for Organics Analysis, Low Concentration Water, Document # OLC02.0
OLM03.0:	USEPA CLP Program, Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration, Document # OLM03.0
ILM04.0:	USEPA CLP Program, Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, Document # ILM04.0
SW846:	Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Final Update III, December 1996.
EPA:	USEPA Office of Research and Development, Environmental Monitoring and Support Laboratory, Methods for Chemical Analyses of Water and Wastes, March 1983
Std. Methods:	Standard Methods for the Examination of Water and Wastewater, 17 th Edition, 1989
HASL:	USDOE Environmental Measurements Laboratory Procedures Manual, 27 th Edition, Revised February 1992
NAREL:	USEPA National Air and Radiation Environmental Laboratory
QC:	Quality Control
VOA:	Volatile Organics Analysis
MS:	Matrix Spike
MSD:	Matrix Spike Duplicate
DUP:	Matrix Duplicate
Equip:	Equipment
PE:	Performance Evaluation
VOC:	Volatile Organic Compounds
SVOC:	Semivolatile Organic Compounds
TPH:	Total Petroleum Hydrocarbons
TVPH:	Total Volatile Petroleum Hydrocarbons
TEPH:	Total Extractable Petroleum Hydrocarbons
Eh:	Oxidation reduction potential
Diss:	Dissolved
TSS:	Total Suspended Solids
TDS:	Total Dissolved Solids
TOC:	Total Organic Carbon
COD:	Chemical Oxygen Demand
HCl:	Hydrochloric Acid

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HNO ₃ :	Nitric Acid
H ₂ SO ₄ :	Sulfuric Acid
°C:	Degrees Celsius
ml:	milliliter
oz:	ounce
poly:	polyethylene
NA:	Not Applicable

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Table B.4.4-1
SUMMARY OF CALIBRATION AND
QC PROCEDURES FOR SCREENING METHODS

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a
EPA 120.1	Conductance	Calibration check with KCl standard	Once per day at beginning of testing	$\pm 5\%$	If calibration is not achieved, check meter, standards, and probe; recalibrate
		Method blank (using DI water)	Once per day at the beginning of testing	< Quantitation Limit (1 μ S/cm)	Check meter, replace if necessary, check water, recalibrate
		Standard check	At each sample location ^c	$\pm 5\%$	Correct problem, recalibrate
		Method duplicate	10% of field samples	RPD $\leq 10\%$	Correct problem, repeat measurement
EPA 180.1	Turbidity	Calibration check with one formazin standard per instrument range used	Once per day at the beginning of testing	± 5 units 0-100 range ± 0.5 units 0-0.2 range ± 0.2 units 0-1 range	If calibration is not achieved, check meter; replace if necessary, recalibrate
		Method blank (using DI water)	Once per day at the beginning of testing	< Quantitation Limit (1 NTU)	Check meter, replace if necessary, check water, recalibrate
		Method duplicate	10% of field samples	RPD $\leq 20\%$	Correct problem, repeat measurement
SW-846 9040B & 9045C	pH (water & sediment)	2-point calibration with pH buffers	Once per day	± 0.05 pH units for every buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration
		pH 7 buffer (standard check)	At each sample location (water only)	± 0.2 pH units	Correct problem, recalibrate
		Method duplicate	10% of field samples	± 0.2 pH units	Correct problem, repeat measurement

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Table B.4.4-1
SUMMARY OF CALIBRATION AND
QC PROCEDURES FOR SCREENING METHODS

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a
EPA 170.1	Temperature	Method duplicate	10% of field samples	± 1.0 °C	Correct problem, repeat measurement
		Factory calibration	Once at factory	± 1.0 °C	Check meter, replace if necessary
EPA 360.1	Dissolved Oxygen	Calibration (as applicable for instrument used)	Once per day	To barometric pressure uncorrected for altitude	NA
		Method Duplicate	10% of field samples	± 0.2 mg/L	Correct Problem, repeat measurement
		Colorimetric check	10% of field samples	RPD $\leq 20\%$	Correct problem, repeat measurement
ASTM 1498	Eh	Sensitivity Verification	Daily	Eh should decrease when pH is increased	If Eh increases, correct the polarity of electrodes. If Eh still does not decrease, clean electrodes and repeat procedure
		Calibration check with one standard	Once per day	Two successive readings ± 10 millivolts	Correct problem, recalibrate
		Standard check	At each sample location ^c	± 10 millivolts	Correct problem, recalibrate
		Method Duplicate	10% of field samples	± 50 millivolts	Correct problem, repeat measurement
AP-3086 (sediment)	Total organic carbon	Method blank	Daily or one per batch, whichever is more frequent	< Quantitation Limit (0.2%)	Clean system; reanalyze blank. Repeat until analyte < quantitation limit
		Method Duplicate	5% of samples	RPD $\leq 20\%$	Repeat measurement

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Table B.4.4-1
SUMMARY OF CALIBRATION AND
QC PROCEDURES FOR SCREENING METHODS

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^a
Colormetric Hach Method 8146 or equivalent	Ferrous Iron	Method Blank	Once per day at the beginning of testing	< Quantitation Limit (0.5 mg/l)	Check blank for optical interference, reanalyze blank, repeat until < Quantitation Limit
		Method Duplicate	10% of field samples	RPD \leq 20%	Analyze third aliquot. If still out, flag data
ASTM D422-63 ^b	Particle Size Distribution	Method Duplicate	1 per batch or 5%	RPD \leq 30%	Analyze third aliquot. If still out, flag data
EPA 160.1	Filterable Residue	Analytical Balance check with a standard weight	Once per day at the beginning of testing	\pm 0.1 milligram	Correct problem, adjust balance
		Method Duplicate	1 per batch or 5%	RPD \leq 20%	Analyze third aliquot. If still out, flag data
EPA 160.2	Non-filterable Residue	Analytical Balance check with a standard weight	Once per day at the beginning of testing	\pm 0.1 milligram	Correct problem, adjust balance
		Method Duplicate	1 per batch or 5%	RPD \leq 20%	Analyze third aliquot. If still out, flag data
Std. Method 2320B	Alkalinity	Method Duplicate	1 per batch or 5%	RPD \leq 20%	Analyze third aliquot. If still out, flag data
EPA 410.4	Chemical Oxygen Demand	Method Duplicate	1 per batch or 5%	RPD \leq 20%	Analyze third aliquot. If still out, flag data
		Method Blank	1 per batch or 5%	< Quantitation Limit (5 mg/l)	Clean system, reanalyze blank, repeat until < Quantitation Limit

^a All corrective actions shall be completed as necessary upon QC check failure, documented, and the records shall be maintained.

^b Refer to Table B.4.4-2g for a discussion of precision assessment.

^c Standard check will be completed at each sample location prior to sampling for the first ten sample locations. If acceptance criteria are met for these ten locations, the standard check at each sample location will be discontinued. Daily instrument calibration checks will continue; should the daily instrument calibration check fail, the standard check at each sample location will be reinstituted for that parameter for the balance of the field sampling event.

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Definitions for Table B.4.4-1:

SW846:	Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Final Update III, December 1996.
EPA:	USEPA Office of Research and Development, Environmental Monitoring and Support Laboratory, Methods for Chemical Analyses of Water and Wastes, March 1983
Std. Methods:	Standard Methods for the Examination of Water and Wastewater, 17 th Edition, 1989
QC:	Quality Control
KCl:	Potassium Chloride
%:	Percent
RPD:	Relative Percent Difference
°C:	Degrees Celsius
mg/l:	milligrams per liter
NA:	Not Applicable

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Table B.4.4-2a
VOC – QC ACCEPTANCE CRITERIA - (GROUNDWATER ONLY)

Analyte	Analytical Method ²	Groundwater		
		PRQL (µg/l) ¹	Accuracy (%R) ³	Precision (%RPD) ³
Chloromethane	OLC02.0	1	OLC02.0	OLC02.0
Chloroethene (Vinyl Chloride)	OLC02.0	1	OLC02.0	OLC02.0
Bromomethane	OLC02.0	1	OLC02.0	OLC02.0
Chloroethane	OLC02.0	1	OLC02.0	OLC02.0
Acetone	OLC02.0	5	OLC02.0	OLC02.0
1,1-Dichloroethene	OLC02.0	1	OLC02.0	OLC02.0
Dichloromethane (Methylene Chloride)	OLC02.0	2	OLC02.0	OLC02.0
trans-1,2-Dichloroethene	OLC02.0	1	OLC02.0	OLC02.0
1,1-Dichloroethane	OLC02.0	1	OLC02.0	OLC02.0
cis-1,2-Dichloroethene	OLC02.0	1	OLC02.0	OLC02.0
2-Butanone (MEK)	OLC02.0	5	OLC02.0	OLC02.0
Chloroform	OLC02.0	1	OLC02.0	OLC02.0
1,1,1-Trichloroethane	OLC02.0	1	OLC02.0	OLC02.0
Carbon Tetrachloride	OLC02.0	1	OLC02.0	OLC02.0
Benzene	OLC02.0	1	OLC02.0	OLC02.0
1,2-Dichloroethane	OLC02.0	1	OLC02.0	OLC02.0
Trichloroethene (TCE)	OLC02.0	1	OLC02.0	OLC02.0
1,2-Dichloropropane	OLC02.0	1	OLC02.0	OLC02.0
Bromodichloromethane	OLC02.0	1	OLC02.0	OLC02.0
cis-1,3-Dichloropropene	OLC02.0	1	OLC02.0	OLC02.0
Methyl isobutyl ketone (MIBK)	OLC02.0	5	OLC02.0	OLC02.0
Toluene	OLC02.0	1	OLC02.0	OLC02.0
trans-1,3-Dichloropropene	OLC02.0	1	OLC02.0	OLC02.0

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Table B.4.4-2a
VOC – QC ACCEPTANCE CRITERIA - (GROUNDWATER ONLY)

Analyte	Analytical Method ²	Groundwater		
		PRQL (µg/l) ¹	Accuracy (%R) ³	Precision (%RPD) ³
1,1,2-trichloroethane	OLC02.0	1	OLC02.0	OLC02.0
Tetrachloroethene (PCE)	OLC02.0	1	OLC02.0	OLC02.0
2-Hexanone	OLC02.0	5	OLC02.0	OLC02.0
Dibromochloromethane	OLC02.0	1	OLC02.0	OLC02.0
Chlorobenzene	OLC02.0	1	OLC02.0	OLC02.0
Ethylbenzene	OLC02.0	1	OLC02.0	OLC02.0
Xylenes (total)	OLC02.0	1	OLC02.0	OLC02.0
Styrene	OLC02.0	1	OLC02.0	OLC02.0
Bromoform	OLC02.0	1	OLC02.0	OLC02.0
1,1,2,2-Tetrachloroethane	OLC02.0	1	OLC02.0	OLC02.0
Carbon Disulfide	OLC02.0	1	OLC02.0	OLC02.0
Bromochloromethane	OLC02.0	1	OLC02.0	OLC02.0
1,2-Dibromoethane	OLC02.0	1	OLC02.0	OLC02.0
1,2-Dichlorobenzene	OLC02.0	1	OLC02.0	OLC02.0
1,3-Dichlorobenzene	OLC02.0	1	OLC02.0	OLC02.0
1,4-Dichlorobenzene	OLC02.0	1	OLC02.0	OLC02.0
1,2-Dibromo-3-chloropropane	OLC02.0	1	OLC02.0	OLC02.0
1,2,4-Trichlorobenzene	OLC02.0	1	OLC02.0	OLC02.0

1. PRQL = Project Required Quantitation Limit and also the CRQL from CLP SOW OLC02.0. The laboratory lower limit of detection must be less than the PRQL.
2. Analysis will be performed by GC/MS, in accordance with the specified method or more recent version.
3. Accuracy and precision will be in accordance with the specified method, or more recent version. Field duplicate precision limits are discussed in Section D.1.3.

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Measurement/Data Acquisition

Table B.4.4-2b
SVOC – QC ACCEPTANCE CRITERIA

Analyte	Water				Sediment			
	Analytical Method ²	PRQL (µg/l) ¹	Accuracy (%R) ³	Precision (%RPD) ³	Analytical Method ²	PRQL (µg/kg) ¹	Accuracy (%R) ³	Precision (%RPD) ³
Naphthalene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
2-Methylnaphthalene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Acenaphthylene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Acenaphthene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Fluorene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Phenanthrene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Anthracene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Fluoranthene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Pyrene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Benzo (a) anthracene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Chrysene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Benzo (b) fluoranthene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Benzo (k) fluoranthene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Benzo (a) pyrene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Indeno (1,2,3-cd)-pyrene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Dibenzo (a,h)-anthracene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0
Benzo (g,h,i) perylene	OLC02.0	5	OLC02.0	OLC02.0	OLM03.0	330	OLM03.0	OLM03.0

1. PRQL = Project Required Quantitation Limit and also the CRQL from CLP SOW OLC02.0 and SOW OLM03.0 respectively. The laboratory lower limit of detection must be less than the PRQL.
2. Analysis will be performed by GC/MS, in accordance with the specified method or more recent version.
3. Accuracy and precision will be in accordance with the specified method, or more recent version. Listed precision limits are for laboratory duplicates and MS/MSD analyses; field duplicate precision limits are discussed in Section D.1.3.

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Measurement/Data Acquisition

Table B.4.4-2c
TPH – QC ACCEPTANCE CRITERIA

Analyte	Analytical Method	Groundwater			Surface Water			Sediment		
		PRQL (µg/l) ¹	Accuracy (%R) ⁴	Precision (%RPD) ⁵	PRQL (µg/l) ¹	Accuracy (%R) ⁴	Precision (%RPD)	PRQL (µg/kg) ¹	Accuracy (%R) ⁴	Precision (%RPD) ⁵
TVPH ²	SW-846 8015B	100	65-135	30	NA	NA	NA	NA	NA	NA
TEPH ³	SW-846 8015B	1000	60-140	30	1000	60-140	30	10000	50-150	50

1. PRQL = Project Required Quantitation Limit; the laboratory MDL must be no greater than 1/3 the PRQL.
2. TVPH will encompass the Carbon range of C6 – C10.
3. TEPH will encompass the Carbon range of C10- C36.
4. Accuracy limits for LCS and MS recoveries.
5. Listed precision limits are for laboratory duplicates and MS/MSD analyses; field duplicate precision limits are discussed in Section D.1.3.

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Measurement/Data Acquisition

Table B.4.4-2d
METALS – QC ACCEPTANCE CRITERIA

Analyte	Water ⁶				Sediment			
	Analytical Method ²	PRDL (µg/l) ⁷	Accuracy (%R) ¹	Precision (%RPD) ¹	Analytical Method ²	PRDL (mg/kg)	Accuracy (%R) ¹	Precision (%RPD) ¹
Aluminum	ILM04.0	25	ILM04.0	ILM04.0	ILM04.0	20	ILM04.0	ILM04.0
Antimony	ILM04.0 ⁴	3	ILM04.0	ILM04.0	ILM04.0 ⁴	1	ILM04.0	ILM04.0
Arsenic	SW846 6020B ³	0.2	SW846 6020B	SW846 6020B	ILM04.0 ⁴	4	ILM04.0	ILM04.0
Barium	ILM04.0	200	ILM04.0	ILM04.0	ILM04.0	20	ILM04.0	ILM04.0
Beryllium	ILM04.0	2	ILM04.0	ILM04.0	ILM04.0	0.5	ILM04.0	ILM04.0
Cadmium	ILM04.0	0.4	ILM04.0	ILM04.0	ILM04.0	0.35	ILM04.0	ILM04.0
Calcium	ILM04.0	5000	ILM04.0	ILM04.0	ILM04.0	50	ILM04.0	ILM04.0
Chromium	ILM04.0	7.5	ILM04.0	ILM04.0	ILM04.0	1	ILM04.0	ILM04.0
Cobalt	ILM04.0	50	ILM04.0	ILM04.0	ILM04.0	5	ILM04.0	ILM04.0
Copper	ILM04.0	2	ILM04.0	ILM04.0	ILM04.0	2.5	ILM04.0	ILM04.0
Iron	ILM04.0	100	ILM04.0	ILM04.0	ILM04.0	10	ILM04.0	ILM04.0
Lead	ILM04.0 ⁴	1	ILM04.0	ILM04.0	ILM04.0 ⁴	0.3	ILM04.0	ILM04.0
Magnesium	ILM04.0	5000	ILM04.0	ILM04.0	ILM04.0	50	ILM04.0	ILM04.0
Manganese	ILM04.0	15	ILM04.0	ILM04.0	ILM04.0	1.5	ILM04.0	ILM04.0
Mercury	ILM04.0 ⁵	0.1	ILM04.0	ILM04.0	ILM04.0 ⁵	0.1	ILM04.0	ILM04.0
Nickel	ILM04.0	10	ILM04.0	ILM04.0	ILM04.0	4	ILM04.0	ILM04.0
Potassium	ILM04.0	5000	ILM04.0	ILM04.0	ILM04.0	50	ILM04.0	ILM04.0
Selenium	ILM04.0 ⁴	2.5	ILM04.0	ILM04.0	ILM04.0 ⁴	0.5	ILM04.0	ILM04.0
Silver	ILM04.0 ⁴	1.5	ILM04.0	ILM04.0	ILM04.0	3	ILM04.0	ILM04.0
Sodium	ILM04.0	5000	ILM04.0	ILM04.0	ILM04.0	50	ILM04.0	ILM04.0
Thallium	ILM04.0 ⁴	1.5	ILM04.0	ILM04.0	ILM04.0 ⁴	1	ILM04.0	ILM04.0

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Measurement/Data Acquisition

Table B.4.4-2d
METALS – QC ACCEPTANCE CRITERIA

Analyte	Water ⁶				Sediment			
	Analytical Method ²	PRDL (µg/l) ⁷	Accuracy (%R) ¹	Precision (%RPD) ¹	Analytical Method ²	PRDL (mg/kg)	Accuracy (%R) ¹	Precision (%RPD) ¹
Vanadium	ILM04.0	50	ILM04.0	ILM04.0	ILM04.0	5	ILM04.0	ILM04.0
Zinc	ILM04.0	20	ILM04.0	ILM04.0	ILM04.0	2	ILM04.0	ILM04.0
Total Uranium	Calculated ⁸	10	---	---	Calculated ⁸	100	---	---

- 1 Accuracy and precision criteria will be in accordance with the specified method, or more recent version. Listed precision limits are for laboratory duplicates; field duplicate precision limits are discussed in Section D.1.3.
- 2 Except where noted, analysis will be performed by ICP-AES methods or trace ICP, in accordance with the specified method or more recent version.
- 3 Analysis by ICP-MS
- 4 Analysis by GFAA
- 5 Analysis by CVAA
- 6 Both total and dissolved metal analyses will be completed for all metals except uranium.
- 7 PRDL = Project Required Detection Limit to Meet Applicable and Appropriate Levels of Concern. The laboratory lower limit of detection must be less than or equal to the PRDL; the laboratory must report down to their lower limit of detection.
- 8 The total uranium mass concentration will be calculated from the measured radioactivity of U-234, U-235, and U-238.

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Measurement/Data Acquisition

Table B.4.4-2e
INORGANICS – QC ACCEPTANCE CRITERIA

Analyte	Water				Sediment/Soil			
	Analytical Method	PRQL ⁶ (µg/l)	Accuracy (%R) ⁵	Precision (%RPD) ⁷	Analytical Method	PRQL ⁶ (µg/kg)	Accuracy (%R) ⁵	Precision (%RPD) ⁷
Chloride (Cl-)	SW-846 9056 ⁴	200	90-110	15	SW-846 9056 ^{3, 4}	100	80-120	20
Sulfate (SO ₄ 2-)	SW-846 9056 ⁴	2000	85-115	15	SW-846 9056 ^{3, 4}	2000	80-120	20
Nitrate (NO ₃ -) ¹	SW-846 9056 ⁴	600	88-110	15	SW-846 9056 ^{3, 4}	600	80-120	20
Nitrite (NO ₂ -) ¹	SW-846 9056 ⁴	400	88-110	15	SW-846 9056 ^{3, 4}	600	80-120	20
Carbonate (CO ₃ 2-) ²	Std. Methods 2320B	10000	NA	15	Std. Methods 2320B ³	10000	NA	20
Bicarbonate (HCO ₃ -) ²	Std. Methods M2320B	10000	NA	15	Std. Methods 2320B ³	10000	NA	20
Phosphate (PO ₄ 3-)	EPA 365.1	10	80-120	50	Mod. EPA 365.1 ³	500	80-120	50
Phosphorus	EPA 365.1	10	80-120	50	Std. Methods 4500-P B.4 + 4500-P E	500	80-120	50
Ammonia	EPA 350.1	10	80-120	20	Mod. EPA 350.1 ³	100	80-120	20

- For water samples, nitrite and total nitrate/nitrite will be measured. Nitrate will be calculated as nitrate/nitrite minus nitrite.
For sediment samples, only nitrate/nitrite will be reported (no speciation).
- Standard Method 2320B for alkalinity determines carbonate and bicarbonate concentrations as CaCO₃ equivalents by stoichiometric calculation.
- An aqueous extraction will be performed on the sediment and the aqueous extract will be analyzed by the method indicated.
- Or by EPA 300.0
- Accuracy limits for LCS and MS recoveries as applicable.
- PRQL = Project Required Quantitation Limit. The laboratory lower limit of detection must be less than the PRQL.
- Listed precision limits are for laboratory duplicates and MS/MSD analyses as applicable; field duplicate precision limits are discussed in Section D.1.3.

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Measurement/Data Acquisition

Table B.4.4-2f
RADIONUCLIDES – QC ACCEPTANCE CRITERIA

Analyte	Water				Sediment			
	Analytical Method ¹	Lower Limit of Detection (pCi/l) ²	Counting Error Goal (pCi/l)	Precision (DER) ³	Analytical Method ¹	Lower Limit of Detection (pCi/g) ²	Counting Error Goal (pCi/g)	Precision (DER) ³
Uranium-238	NAREL U/Th-01	0.2	1.5	2	NAREL U/Th-01	0.2	0.2	2
Uranium-235	NAREL U/Th-01	0.2	1.5	2	NAREL U/Th-01	0.2	0.2	2
Uranium-234	NAREL U/Th-01	0.2	1.5	2	NAREL U/Th-01	0.2	0.2	2
Thorium-232	NAREL U/Th-01	0.2	1.5	2	NAREL U/Th-01	0.2	0.2	2
Thorium-230	NAREL U/Th-01	0.2	1.5	2	NAREL U/Th-01	0.2	0.2	2
Thorium-228	NAREL U/Th-01	0.2	1.5	2	NAREL U/Th-01	0.2	0.2	2
Radium-226	NAREL Ra-04	1.0	0.5	2	NAREL Ra-01, Ra-04	0.5	1.5	2
Radium-228	NAREL Ra-05	3.0	1.5	2	NAREL Ra-01, Ra-05	0.5	1.5	2
Protactinium-231	Mod. HASL 300	0.5	0.5	2	NAREL Gam-01	0.2	0.5	2
Actinium-227	Mod. HASL 300	1.5	0.7	2	Mod. HASL 300	0.2	0.5	2
Radon-222	NAREL Gam-01	100	150	2	NA	NA	NA	NA
Lead-210	Mod. HASL 300	5.0	4	2	Mod. HASL 300	3.0	2.0	2
Gross alpha ⁴	NAREL Gr-01	1.0	7.5	2	NA	NA	NA	NA
Gross beta	NAREL Gr-01	3.0	15	2	NA	NA	NA	NA
Decay series analyses for Thorium-232	Refer to Table B4.4-3a	Refer to Table B4.4-3a			Refer to Table B4.4-3a	Refer to Table B4.4-3a		
Decay series analyses for Uranium-235	Refer to Table B4.4-3b	Refer to Table B4.4-3b			Refer to Table B4.4-3b	Refer to Table B4.4-3b		
Decay series analyses for Uranium-238	Refer to Table B4.4-3c	Refer to Table B4.4-3c			Refer to Table B4.4-3c	Refer to Table B4.4-3c		

1. Or equivalent protocol pending approval by EPA.
2. Laboratory Lower Limit of Detection (LLD) must be ≤ the QAPP-listed LLD. The laboratory must report down to their LLD.
3. Precision Duplicate Error Ratio (DER) discussed in Section D.3.1.
Other applicable means of calculating and evaluating precision thresholds (DER or RER) exist and will be considered as necessary and appropriate.
Listed precision limits are for laboratory duplicates and MS/MSD analyses as applicable; field duplicate precision limits are discussed in Section D.1.3.
4. Laboratory must subtract contribution from radon and uranium before reporting gross alpha.

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Measurement/Data Acquisition

Table B.4.4-2g
OTHER PARAMETERS – QC ACCEPTANCE CRITERIA

Analyte	Water	Groundwater		Surface Water		Sediment		
	Analytical Method	PRQL ¹	Precision ⁶	PRQL ¹	Precision ⁶	Analytical Method	PRQL ¹	Precision ⁶
pH	SW-846 9040B	NA	± 0.2 pH units	NA	± 0.2 pH units	SW-846 9045C	NA	± 0.2 pH units
Temperature	EPA 170.1	NA	± 1.0 °C	NA	± 1.0 °C	NA	NA	NA
Specific Conductance	EPA 120.1	1µS/cm	10 %RPD	1µS/cm	10 %RPD	NA	NA	NA
Eh	ASTM 1498	± 300 mV	± 50 mV	± 300 mV	± 50 mV	NA	NA	NA
Dissolved oxygen	EPA 360.1	0.2 mg/L	20 %RPD	0.2 mg/L	20 %RPD	NA	NA	NA
Ferrous iron	Mod. Hach #8146	0.5 mg/L	20 %RPD	0.5 mg/L	20 %RPD	NA	NA	NA
Total suspended solids	EPA 160.2	4 mg/L	20 %RPD	4 mg/L	20 %RPD	NA	NA	NA
Total dissolved solids	EPA 160.1	10 mg/L	20 %RPD	10 mg/L	20 %RPD	NA	NA	NA
Total organic carbon	NA	NA	NA	NA	NA	AP-3086	0.2 %	20 %RPD
Alkalinity	Std. Methods 2320 B ²	20 mg/L	20 %RPD	20 mg/L	20 %RPD	NA	NA	NA
Hardness	Std. Methods 2340 B ³	35 mg/L	20 %RPD	20 mg/L	20 %RPD	NA	NA	NA
Turbidity	EPA 180.1	0 NTU	20 %RPD	0 NTU	20 %RPD	NA	NA	NA
Chemical Oxygen Demand	EPA 410.4	NA	NA	5 mg/L	20 %RPD	NA	NA	NA
% Organic Matter	NA	NA	NA	NA	NA	(4)	0.2 %	20 %RPD
Particle Size Distribution ⁵	NA	NA	NA	NA	NA	ASTM D422-63	NA	30 %RPD

1. PRQL: Project Required Quantitation Limit. The laboratory lower limit of detection must be less than the PRQL.
2. Alkalinity due to carbonate, bicarbonate and hydroxide will be reported.
3. Hardness will be calculated by the laboratory from major cation results.
4. %Organic matter will be calculated from the total organic carbon results using the following equation:

$$\% \text{Organic matter} = (\text{TOC} + 0.4)/0.458 \quad (\text{Ball, Journal Soil Science 15:84-92, 1964})$$
5. Precision will be calculated for laboratory/method duplicates. Particle sizes larger than 75 µm determined by sieving; particle sizes smaller than 75 µm determined by sedimentation using a hydrometer. The results of this test method are presented in the form of a graph, with the diameters of the particles plotted on a logarithmic scale as the abscissa and the percentages smaller than the corresponding diameters plotted on an arithmetic scale as the ordinate. For use as an acceptance criterion, an RPD will be calculated for each point on the graph. For the hydrometer portion, it may be necessary to extrapolate the percent passing for a given particle diameter in order to calculate an RPD.
6. Listed precision limits are for laboratory duplicates and MS/MSD analyses as applicable; field duplicate precision limits are discussed in Section D.1.3.

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Definitions for Tables B.4.4-2a – B.4.4-2g:

PRDL:	Project Required Detection Limit to Meet Applicable and Appropriate Levels of Concern
PRQL:	Project Required Quantitation Limit to Meet Applicable and Appropriate Levels of Concern
OLC02.0:	USEPA CLP Program, Statement of Work for Organics Analysis, Low Concentration Water, Document # OLC02.0
OLM03.0:	USEPA CLP Program, Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration, Document # OLM03.0
ILM04.0:	USEPA CLP Program, Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, Document # ILM04.0
SW846:	Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Final Update III, December 1996.
EPA:	USEPA Office of Research and Development, Environmental Monitoring and Support Laboratory, Methods for Chemical Analyses of Water and Wastes, March 1983
Std. Methods:	Standard Methods for the Examination of Water and Wastewater, 17 th Edition, 1989
HASL:	USDOE Environmental Measurements Laboratory Procedures Manual, 27 th Edition, Revised February 1992
NAREL:	USEPA National Air and Radiation Environmental Laboratory
%R:	Percent Recovery
%RPD:	Percent Relative Percent Difference
µg/l:	micrograms per liter
µg/kg:	micrograms per kilogram
mg/kg:	milligrams per kilogram
mg/l:	milligrams per liter
pCi/l:	picocuries per liter
pCi/g:	picocuries per gram
µS/cm:	microsiemens per centimeter
µm:	micrometer
mV:	millivolts
NTU:	Nephelometric turbidity units
DER:	Duplicate Error Ratio
QC:	Quality Control
VOC:	Volatile Organic Compounds
SVOC:	Semivolatile Organic Compounds
TPH:	Total Petroleum Hydrocarbons
TVPH:	Total Volatile Petroleum Hydrocarbons
TEPH:	Total Extractable Petroleum Hydrocarbons
Eh:	Oxidation reduction potential
NA:	Not Applicable
LCS:	Laboratory Control Spike

SECTION B

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MS:	Matrix Spike
ICP-AES:	Inductively Coupled Plasma-Atomic Emission Spectrometer
ICP-MS:	Inductively Coupled Plasma-Mass Spectrometer
GFAA:	Graphite Furnace Atomic Absorption
CVAA:	Cold Vapor Atomic Absorption

SECTION B

Measurement/Data Acquisition

Table B.4.4-3a
THORIUM 232
DECAY SERIES ANALYSES

Th-232 Series Aqueous	Half Life	Method ¹	Lower Limit of Detection ² (pCi/l)	Counting Error Goal (pCi/l)	Precision (DER) ³
Th232	1.4 E10y	NAREL U/Th-01 ⁴	0.2	1.5	2
Ra228	6.7 y	NAREL Ra-05 ⁴	3	1.5	2
Ac228	6.13 hr	Not Meaningful	----	----	----
Th228	1.91 y	NAREL U/Th-01 ⁴	0.2	1.5	2
Ra224	3.64 d	Not Meaningful	----	----	----
Rn220	55 s	Not Meaningful	----	----	----
Po216	.15 s	Not Meaningful	----	----	----
Pb212	10.64 hr	Not Meaningful	----	----	----
Bi212	60.6 m	Not Meaningful	----	----	----
Po212	3E-7 s	Not Meaningful	----	----	----
Tl208	3.1 m	Not Meaningful	----	----	----
Sediment			(pCi/g)	(pCi/g)	
Th232	1.4 E10y	NAREL U/Th-01 ⁴	0.2	0.2	2
Ra228	6.7 y	NAREL Ra-01, Ra-05 ⁴	0.5	1.5	2
Ac228	6.13 hr	Not Meaningful	----	----	----
Th228	1.91 y	NAREL U/Th-01 ⁴	0.2	0.2	2
Ra224	3.64 d	Not Meaningful	----	----	----
Rn220	55 s	Not Meaningful	----	----	----
Po216	.15 s	Not Meaningful	----	----	----
Pb212	10.64 hr	Not Meaningful	----	----	----
Bi212	60.6 m	Not Meaningful	----	----	----
Po212	3E-7 s	Not Meaningful	----	----	----
Tl208	3.1 m	Not Meaningful	----	----	----

- Those Isotopes listed as not meaningful have relatively short half-lives (and/or low dose factors) and will not be directly measured; however, relative concentrations can be calculated from other isotopes in the decay series. Proposed/equivalent analytical methods may be used pending EPA approval.
- Lower Limits of Detection Listed may be affected by sample Total Dissolved Solids Content. Laboratory Lower Limit of Detection (LLD) must be ≤ the QAPP-listed LLD. The laboratory must report down to their LLD.
- Precision Duplicate Error Ratio (DER) is discussed in Section D.3.1
Other applicable means of calculating and evaluating precision thresholds (DER or RER) exist and will be considered as necessary and appropriate.
- No additional analysis required as this isotope is already scheduled to be analyzed in each sample (Table B.4.4-2f).

SECTION B

Measurement/Data Acquisition

Table B.4.4-3b
URANIUM 235
DECAY SERIES ANALYSES

U235 Series Aqueous	Half Life	Method ¹	Lower Limit of Detection ² (pCi/l)	Counting Error Goal (pCi/l)	Precision (DER) ³
U235	7.1E+8 y	NAREL U/Th-01 ⁴	0.2	1.5	2
Th231	25.5 h	Not Meaningful	----	----	----
Pa231	3.25E+4 y	Modified HASL ⁴	0.5	0.5	2
Ac227	21.6 y	Modified HASL ⁴	1.5	0.7	2
Th227	18.2 d	NAREL U/Th-01	2	2	2
Fr223	22 m	Not Meaningful	----	----	----
Ra223	11.43 d	Not Meaningful	----	----	----
Rn219	4.0 s	Not Meaningful	----	----	----
Po215	1.77E-3 s	Not Meaningful	----	----	----
Pb211	36.1 m	Not Meaningful	----	----	----
Bi211	2.16 m	Not Meaningful	----	----	----
Po211	0.52 s	Not Meaningful	----	----	----
Tl207	4.79 m	Not Meaningful	----	----	----
Sediment			(pCi/g)	(pCi/g)	
U235	7.1E+8 y	NAREL U/Th-01 ⁴	0.2	0.2	2
Th231	25.5 h	Not Meaningful	----	----	----
Pa231	3.25E+4 y	NAREL Gam-01 ⁴	0.2	0.2	2
Ac227	21.6 y	Modified HASL ⁴	0.2	0.5	2
Th227	18.2 d	NAREL U/Th-01	2	2	2
Fr223	22 m	Not Meaningful	----	----	----
Ra223	11.43 d	Not Meaningful	----	----	----
Rn219	4.0 s	Not Meaningful	----	----	----
Po215	1.77E-3 s	Not Meaningful	----	----	----
Pb211	36.1 m	Not Meaningful	----	----	----
Bi211	2.16 m	Not Meaningful	----	----	----
Po211	0.52 s	Not Meaningful	----	----	----
Tl207	4.79 m	Not Meaningful	----	----	----

- Those Isotopes listed as not meaningful have relatively short half-lives (and/or low dose factors) and will not be directly measured; however, relative concentrations can be calculated from other isotopes in the decay series. Proposed/equivalent analytical methods may be used pending EPA approval.
- Lower Limits of Detection Listed may be affected by sample Total Dissolved Solids Content. Laboratory Lower Limit of Detection (LLD) must be ≤ the QAPP-listed LLD. The laboratory must report down to their LLD.
- Precision Duplicate Error Ratio (DER) is discussed in Section D.3.1
Other applicable means of calculating and evaluating precision thresholds (DER or RER) exist and will be considered as necessary and appropriate.
- No additional analysis required as this isotope is already scheduled to be analyzed in each sample (Table B.4.4-2f).

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Table B.4.4-3c
URANIUM 238
DECAY SERIES ANALYSES

U238 Series Aqueous	Half Life	Method ¹	Lower Limit of Detection ² (pCi/l)	Counting Error Goal (pCi/l)	Precision (DER) ³
U238	4.5E+9 y	NAREL U/Th-01 ⁴	0.2	1.5	2
Th234	24.1 d	Modified HASL	5	5	2
Pa234	1.17 m	Not Meaningful	----	----	----
U234	2.46E+5 y	NAREL U/Th-01 ⁴	0.2	1.5	2
Th230	8E+4y	NAREL U/Th-01 ⁴	0.2	1.5	2
Ra226	1622 y	NAREL Ra-04 ⁴	1	0.5	2
Rn222	3.8 d	NAREL Gam-01 ⁴	100	150	2
Po218	3.05 m	Not Meaningful	----	----	----
Pb214	26.8 m	Not Meaningful	----	----	----
Bi214	19.7 m	Not Meaningful	----	----	----
Pb210	21 y	Modified HASL ⁴	5	4	2
Po210	138.4 d	Modified HASL	0.5	0.15	2
Sediment			(pCi/g)	(pCi/g)	
U238	4.5E+9 y	NAREL U/Th-01 ⁴	0.2	0.2	2
Th234	24.1 d	Not Meaningful	----	----	----
Pa234	1.17 m	Not Meaningful	----	----	----
U234	2.46E+5 y	NAREL U/Th-01 ⁴	0.2	0.2	2
Th230	8E+4y	NAREL U/Th-01 ⁴	0.2	0.2	2
Ra226	1622 y	NAREL Ra-01, Ra-04 ⁴	0.5	1.5	2
Rn222	3.8 d	Not Meaningful	----	----	----
Po218	3.05 m	Not Meaningful	----	----	----
Pb214	26.8 m	Not Meaningful	----	----	----
Bi214	19.7 m	Not Meaningful	----	----	----
Pb210	21 y	Modified HASL ⁴	3	2	2
Po210	138.4 d	Modified HASL	0.5	0.15	2

- Those Isotopes listed as not meaningful have relatively short half-lives (and/or low dose factors) and will not be directly measured; however, relative concentrations can be calculated from other isotopes in the decay series. Proposed/equivalent analytical methods may be used pending EPA approval.
- Lower Limits of Detection Listed may be affected by sample Total Dissolved Solids Content. Laboratory Lower Limit of Detection (LLD) must be ≤ the QAPP-listed LLD. The laboratory must report down to their LLD.
- Precision Duplicate Error Ratio (DER) is discussed in Section D.3.1
Other applicable means of calculating and evaluating precision thresholds (DER or RER) exist and will be considered as necessary and appropriate.
- No additional analysis required as this isotope is already scheduled to be analyzed in each sample (Table B.4.4-2f).

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Measurement/Data Acquisition

Definitions for Tables B.4.4-3a, B.4.4-3b, B.4.4-3c

Th	Thorium
Ra	Radium
Ac	Actinium
Rn	Radon
Po	Polonium
Pb	Lead
Bi	Bismuth
Tl	Thallium
U	Uranium
Pa	Protactinium
Fr	Francium

y	years
d	days
hr	hours
m	minutes
s	seconds

pCi/l	picocuries per liter
pCi/g	picocuries per gram

EPA	USEPA Office of Research and Development, Environmental Monitoring and Support Laboratory, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, August 1980
HASL	USDOE Environmental Measurements Laboratory Procedures Manual, 27th Edition, Revised February 1992
NAREL	USEPA National Air and Radiation Environmental Laboratory

SECTION C

Assessment/Oversight

C.1 ASSESSMENTS AND RESPONSE ACTIONS

C.1.1 Purpose/Background

A process of evaluation and validation is necessary to ensure that data collection is conducted according to this QAPP. The Project QA Manager, whose responsibilities are described in Section A.4, will have the primary responsibility for implementing the internal and external assessments necessary to assure:

- all elements of this QAPP are correctly implemented as prescribed,
- the quality of the data generated through implementation of this QAPP is adequate to meet the stated DQOs, and
- corrective actions are implemented in a timely manner, properly documented, and their effectiveness confirmed.

These internal and external assessments are described in the following sections. If at any time in the assessment process it is discovered that this QAPP is not being correctly implemented, the quality of the data being generated is not adequate to meet project DQOs, or corrective actions are not completed as necessary, the Project QA Manager will immediately notify the project manager. It is the responsibility of the project manager to resolve problems and/or issue stop work orders as necessary.

C.1.2 Assessment Activities and Project Planning

Assessment activities to be implemented assuring data collection is conducted according to this QAPP follow.

C.1.2.1 Assessment of Subsidiary Organizations

Management Systems Review (MSR). The Project QA Manager or his designee may complete a MSR for all sub-contracted laboratories prior to sample collection. The MSR will be an assessment of the sub-contracted laboratory's quality management structure, policies, practices, and procedures to establish that the sub-contracted laboratory is capable of obtaining the type and quality of data required for this project. The MSR may include the following.

- A qualitative review of the sub-contracted laboratory's quality assurance plan. Internal QA procedures, key personnel and responsibilities, organizational charts, corrective action procedures, reporting procedures, documentation procedures, lists of standard operating procedures (SOPs), lists of instrumentation, instrumentation maintenance schedules, and data review, verification, and reporting procedures should all be clearly presented and described. The laboratory's quality assurance plan should be a controlled document, dated, signed by the laboratory's QA Manager, and updated or reviewed at least every two years.

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- Confirmation that the laboratory has documented SOPs for sample receipt and storage, data review, verification, and reporting, and all methods to be performed by the subcontracted laboratory. Method SOPs should contain appropriate method citations, all deviations from the cited EPA methods, control windows, corrective actions, and quantitation limits. SOPs should be dated, signed by the laboratory's QA Manager, and updated or reviewed at least every two years.
- A qualitative review of performance evaluation studies from the past year. As applicable, the contracted laboratory should provide at least the most recent two sets of results for each method to be performed from their participation in the National Voluntary Laboratory Accreditation Program, EPA laboratory proficiency program, or EPA interlaboratory studies.
- A quantitative comparison of the laboratory's quantitation limits and method detection limits against project-required detection or quantitation limits for all target analytes to be determined. Method detection limits must be current and equal to or below the project-required detection or quantitation limits.

Sample Receipt Review. The laboratory's project manager will review all sample login information and will fax URSG chains of custody and sample login information by close of business each day samples are received. The laboratory's project manager will immediately notify URSG if there is any problem with sample receipt (i.e. broken samples, elevated temperature blanks, etc).

Technical Systems Audit (TSA). A TSA is a thorough and systematic onsite qualitative audit where laboratory facilities, method implementation, data reduction and reporting procedures, equipment, personnel, training, procedures, and record keeping are examined for conformance to this QAPP. Any deviations revealed during a TSA will be communicated to the URSG and EPA project managers and the laboratory in an audit findings report. The laboratory must respond to the audit findings report and provide detailed corrective actions. The Project Manager may issue a stop work order if any finding seriously effects the data quality objectives. The Project QA Manager or his designee may conduct a TSA of the subcontracted laboratory at any time during working hours for the duration of the project.

A TSA may be completed on one or more contracted laboratories prior to or during the first sampling event.

C.1.2.2 Assessment of Project Activities

Surveillance. The Project QA Manager will periodically review project records, such as field log books and field forms and question project personnel to assure that QAPP-specified requirements are being met. If surveillance reveals QAPP requirements are not being met, the Project QA Manager will suggest corrective actions to the URSG Project Manager. The Project QA Manager will continue surveillance to assure the corrective action is implemented.

TSA. A TSA is a thorough and systematic onsite qualitative audit where field procedures, equipment, personnel, training, and record keeping are examined for conformance to this QAPP (and supporting SAP and SOPs). Any deviations revealed during a TSA will be communicated to

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the URSG Project Manager in an audit findings report. The audit findings report will consist of audit observations and audit findings. Audit observations include discovery of items not negatively impacting data quality and recommendations for improvements in current procedures. Audit findings consist of items which negatively impact data quality and therefore require resolution. URSG's Project Manager must respond to the audit findings report and provide detailed corrective actions (Section C.1.3). The Project Manager may issue a stop work order if any finding seriously affects the data quality objectives. The Project QA Manager or his designee may conduct a TSA of the field procedures at any time for the duration of the project. A TSA of field procedures is scheduled during the first sampling event.

Performance Evaluation (PE). A PE audit may be conducted to assess the quantitative data generated by the laboratories. Blind PE samples for VOCs, SVOCs, metals, common ions and radionuclides may be included with routine sample shipments for any given sampling effort. PE samples will be spiked with a subset of analytes listed in Section B of this QAPP at levels no higher than ten times and no lower than the quantitation limit. The results of the PE samples will be assessed for bias, precision, and quantitation limits. If results from one PE audit are unacceptable, the Project QA Manager will notify the laboratory and ask the laboratory to investigate possible problems and implement corrective actions. The laboratory's QA manager should provide the URSG Project QA Manager with a report of the investigation findings and any corrective actions implemented. The URSG Project QA Manager may direct issue of a second PE sample to assess corrective action efficacy. If results from more than one PE audit are unacceptable, the Project QA Manager will notify the URSG Project Manager, who may issue a stop work order until the source of the problem can be identified and appropriate corrective actions are implemented.

PE samples may be sent to contracted laboratories with samples from the first sampling event for some to all of the definitive analytical methods (as listed in Table B.4.3-1). A decision on the use of PE samples will be based on the laboratories contracted to complete the work and the availability of appropriate (parameter and concentration range) PE samples.

Audit of Data Quality (ADQ). The Project Manager may conduct an ADQ to evaluate how project personnel handled data, made judgements, and whether uncorrected mistakes were made. Peer reviews will be conducted on this project instead of ADQs.

Peer Review. Peer reviews will be completed for the documents listed in Table C.1-1. Peer reviews will be completed by reviewers, independent of the project with technical expertise comparable to or greater than the product authors. The reviewer will evaluate whether the document is technically adequate, is competently prepared, is properly documented, satisfies technical requirements, and satisfies QA requirements. All findings and responses will be maintained in the project file.

Data Quality Assessment (DQA). A DQA report will be prepared to document the overall quality of data collected in terms of project DQOs and the effectiveness of the data collection and generation processes. The data assessment parameters calculated from the results of the field measurements and laboratory analyses will be reviewed to assure that all data used in subsequent evaluations are scientifically valid, of known and documented quality, and, where

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appropriate, legally defensible. In addition, the performance of the overall measurement system will be evaluated in terms of the completeness and effectiveness of field measurement and data collection procedures. Finally, the goal of the DQA is to present the findings in terms of data usability.

The degree of total error in the results derived from data collection must be determined, so that the level of confidence in decisions based on the results can be known. The methods and procedures used to determine total error follow:

- Assess the quality of measured data to assure that each value is scientifically valid, of known and documented quality, and, where appropriate, legally defensible. This will be accomplished by assessing actual data values project DQOs for parameters such as precision, accuracy, completeness, representativeness, and comparability (defined in Section D), and by evaluating each value against its acceptance criteria presented in Section B.
- Data that pass pre-established QC checks will be considered useable. Data that fail pre-established QC checks will be evaluated for usability against project DQOs. These data may be determined valid without qualification, may be qualified for limited use, or may be qualified as unusable (rejected) for any use.

The major components of the DQA are presented below and show the logical progression of the assessment leading to determination of data usability:

- **Data Validation Summary.** Summarizes the individual data validation reports for all sample delivery groups by analytical method. Systematic problems, data generation trends, general condition of the data, and reasons for data qualification are presented.
- **Data Evaluation Procedures.** Describes the procedures used to further qualify data caused by such factors as dilution, reanalysis, matrix effect, and imprecision between duplicate analysis of samples. Examples of the decision logic are provided to illustrate the methods by which qualifiers are applied.
- **QC Sample Evaluation.** Evaluates applicable QC samples such as ambient blanks, trip blanks, equipment blanks, field duplicates, PE samples and laboratory control samples to assess the quality of the field activities and laboratory procedures.
- **Assessment of Data Quality Objectives.** Assesses the quality of data measured and generated in terms of accuracy, precision, representativeness, and completeness through the examination of laboratory and field control samples in relation to DQOs (Section D). Evaluate the quantitation limits and method detection limits, as adjusted for dilution and dry weight to determine if they are below preliminary ARARs.
- **Summary of Data Usability.** Summarizes the usability of data, based on the assessment of data conducted during the previous four steps. Sample results for each analytical method will be qualified as acceptable, rejected, estimated, biased high, or biased low.

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C.1.2.3 Schedule of Assessment Activities and Personnel

Table C.1-2 presents the schedule for assessment activities and personnel.

C.1.3 Nonconformance and Corrective Actions

It is the intent of the quality assurance process to minimize corrective actions through the development and implementation of effective internal controls. To accomplish this, procedures are implemented that will activate a corrective action for a measurement system when acceptance criteria have been exceeded. In addition reviews and technical systems audits will be conducted on a periodic basis to check this implementation.

Provisions for establishing and maintaining QA reporting to the appropriate management authority will be instituted to assure that early and effective corrective action can be taken when data quality falls outside project DQOs (acceptance criteria). In this context, corrective action involves the following steps:

- Discovery of a nonconformance,
- Identification of the responsible party to allow formulation of an appropriate corrective action,
- Planning and scheduling of corrective action,
- Review of the corrective action taken, and
- Confirmation that the desired results were produced.

Activities subject to QC and QA will be evaluated for compliance with project DQOs. These activities include both field and laboratory operations as described in this QAPP. A lack of compliance with these procedures will constitute a nonconformance. The Project QA Manager, or any project member who discovers or suspects a nonconformance (including subcontractors), is responsible for initiating a nonconformance report. The URSG Project Manager will assure that no additional work, which is adversely affected by the nonconforming activity, is performed until a confirmed nonconformance is corrected.

The Project QA Manager will be responsible for reviewing all assessment, audit and nonconformance reports to determine areas of poor quality or failure to adhere to established procedures. The Project QA Manager will report nonconformances directly to the URSG Project Manager. The URSG Project Manager will be responsible for evaluating all reported nonconformances, conferring with the Project QA Manager on the corrective action, and executing the corrective action. Corrective actions will be selected to prevent or reduce the likelihood of future nonconformances and address the causes of the nonconformance. Corrective actions should be appropriate to the seriousness of the nonconformance and realistic in terms of the resources required for implementation.

Upon completion of the corrective action, the Project QA Manager will evaluate the effectiveness of the corrective action. If the corrective action is found to be adequate, the Project

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QA Manager will notify the URSG Project Manager of the satisfactory corrective action. If the corrective action is found inadequate, the Project QA Manager and URSG Project Manager will confer to resolve the problem and determine any further corrective actions. Implementation of any further action will be scheduled by the URSG Project Manager. The Project QA Manager may issue a stop work order in cases in which significant problems continue or corrective actions were not completed. The EPA Work Assignment Manager will be notified prior to any stop work order.

C.2 REPORTS TO MANAGEMENT

All audit finding reports, nonconformance reports, corrective action reports and stop work orders will be transmitted, as they occur, to the EPA Work Assignment Manager, and URSG Project Manager. Peer reviews, MSRs, and readiness reviews will be transmitted, as they occur to the URSG Project Manager. Otherwise, the routine evaluations of data quality described Section C.1 of this QAPP will be documented and filed along with the data in the program files. DQAs may be included in any final reports that present and summarize data generated.

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Table C.1-1
TABLE OF PEER REVIEWS AND REVIEWERS

Document	Reviewer	Title
QAPP	Alan Roberts	URSG Project Quality Assurance Manager
Field Sampling Plan	Jeff Ehrenzeller	URSG Senior Hydrogeologist
Standard Operating Procedures	Jeff Ehrenzeller	URSG Senior Hydrogeologist
Field and Sample Forms	Scott Myers	URSG Project Manager
Technical SOWs	Alan Roberts	URSG Project Quality Assurance Manager
Data Validation Reports	Alan Roberts	URSG Project Quality Assurance Manager

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Table C.1-2
SCHEDULE OF ASSESSMENT ACTIVITIES AND PERSONNEL

Assessment Activity	Timing	Frequency	Responsible Personnel
MSR	Before first sample collection begins	Once for each sub-contracted laboratory	Project Quality Assurance Manager
Sample Receipt Review	During sample collection	Each day samples are received	Laboratory's project manager
TSA	Any time during the project	At the discretion of the Project Quality Assurance Manager or Project Manager	Project Quality Assurance Manager
Surveillance	During sample collection	At least once per sampling event	Project Quality Assurance Manager
PE	During sample collection and analyses	As often as quarterly	Project Quality Assurance Manager
Peer Review	Before a document is finalized	Once per document	Technical staff
DQA	After data is validated	Once for each sampling event	Project Quality Assurance Manager

SECTION D

Data Validation and Usability

D.1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

This section describes the process for determining that project data were collected in a way that meets at least the specified QC acceptance criteria (verification) and determining that project results are suitable for use in making the specified decision (validation).

D.1.1 Introduction

The analytical data review process for analyses to be conducted under this QAPP will consist of two levels of review. The first level of review is performed by the analytical laboratory. The laboratory review program is designed to ensure that analytical data of known and acceptable quality have been provided by the laboratory. The second level of review is to be conducted by a person(s) independent of the laboratory. The review of data packages received from the laboratory is designed to evaluate whether the data generated are of sufficient quality for their intended use. The independent data validation process will be used to make an overall assessment of the data set and the usability of each analytical result.

The laboratory will review and verify 100% of all data generated at the laboratory and field personnel will review and verify 100% of all data generated in the field.

All URSG data review, validation and verification will be performed by qualified chemists (either by degree or experience) who were not involved in data generation.

If data review and/or validation is completed by EPA following data package delivery from an EPA laboratory or EPA-contracted laboratory through the Contract Laboratory Program (CLP), EPA Region X validation procedures will be followed and documented in the validation report.

The following paragraphs specify criteria to be used in data review, verification and validation.

D.1.2 Laboratory Data Reduction, Verification, and Reporting

The specific data reduction, verification, and reporting procedures and assigned personnel will vary from laboratory to laboratory, but will be completed in accordance with the laboratory's QAP and SOPs. However, equivalent procedures must be performed to assure that accurate and consistent data handling, review, and reporting are achieved.

The laboratory analyst is responsible for the reduction of raw data generated at the laboratory bench. The analyst must verify that data reduction performed by an instrument or Laboratory Information Management System is correct.

The laboratory or field personnel will verify all generated data as follows.

- Verify calibrations and calibration checks for compliance with laboratory criteria and criteria presented in Section B.4.
- Verify that batch QC samples were analyzed at the frequency specified in Section B.4.
- Verify that QC sample results were within the specifications in Section B.4.

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- Compare raw data (chromatograms, etc.) with the reported concentrations for accuracy and consistency.
- Verify that holding times for extractions and analyses were met.
- Verify that quantitation limits and method detection limits are current and correct.
- Determine whether corrective actions were performed and control was adequately reestablished and documented prior to reanalysis of QC or project samples.
- Verify that all project and QC sample results were properly reported and flagged.
- Prepare batch narratives that adequately identify and discuss any problems encountered.

These QC checks will be reviewed by laboratory analysts or field personnel, supervisors, QC specialists and the assigned laboratory project manager, or by a combination of these staff. After the data have been reviewed and verified, the laboratory or field reports are signed and released for distribution.

The content and format of laboratory electronic data deliverables will be formulated at a later date following identification of the laboratories to be used in support of the Phase 1A Field Investigation. Deferring this decision until after the identification of analytical laboratories is complete allows for the formulation of an electronic deliverable requirement that best meets the end data validation and data management needs. For example, procurement of laboratories through the CLP would dictate the need for electronic data to be delivered in a format amenable to EPA software validation.

D.1.3 Data Validation

The second level of review and validation of the analytical data produced under this QAPP will be performed by data validation personnel independent of the laboratory generating the data. The purpose of this second level of review is to provide an independent review of the data package and will include a review of laboratory performance criteria and sample-specific criteria.

The first level of data review by the analytical laboratory includes a thorough review of laboratory performance criteria (which are independent of the field samples being analyzed). The independent validation will include a verification of the laboratory review of the performance criteria for 10 percent of the data packages for each analysis type and each laboratory for those operations that are in the control of the laboratory (as described in Section D.1.3.1) to verify that the laboratory QC program was functioning adequately and that the laboratory met the performance criteria. The second level of review will also include a review of sample-specific criteria for 100 percent of the data packages from each laboratory for each analysis type for those parameters that are sample-related such as: consistency with the chain-of-custody, holding times, surrogate recoveries, matrix spike recoveries, field duplicate agreement, matrix spike duplicate and laboratory duplicate precision, post digestion (analytical) spike recoveries, ICP serial dilution analysis agreement, and qualification of sample data based on analytes reported as detected in blank analyses as described in Section D.1.3.2. Since

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Data Validation and Usability

transcription and calculation are reviewed and verified by the laboratory and are in the laboratory's control, these parameters will be evaluated from the results reported by the laboratory. Any significant problems identified during the review of the laboratory performance criteria that indicate a systematic problem will also be included during the review of the sample-specific criteria.

The analytical sample data for organics by gas chromatography (GC), gas chromatography/mass spectrometry (GC/MS), metals by Inductively Coupled Plasma Emission Spectroscopy (ICP), metals by ICP-Mass Spectrometry (ICP-MS), metals by Cold Vapor Atomic Absorption (CVAA), or metals by Graphite Furnace Atomic Absorption Spectroscopy (GFAA) for samples analyzed under this QAPP will be validated using guidance from U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, February 1994 (EPA 1994c), U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, February 1994 (EPA 1994b), and Section D of this QAPP. The analytical data for radiological parameters will be validated using guidance from Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses, Revision 05A written by Science Application International Corporation (SAIC) in April 1993, and Section D of this QAPP. Other data will be validated by implementing all applicable data validation protocols outlined in this QAPP and the principal criteria outlined below, where applicable.

The laboratory(s) will be contacted with regard to any missing or incorrect deliverables in the data packages noted during the validation process. The data reviewer will document all subsequent submittals and resubmittals from the laboratory, recalculations, and data reviewer corrections. After all laboratory data packages have been validated, compliance with the QA objective of completeness, specified in Section A.7.4 and D.3.3 of this QAPP, will be assessed. Reports will be written by the data reviewer summarizing the results of the data validation and the impact on the quality and usability of the data.

During data validation qualifiers may be assigned. Data qualifiers are defined in Section D.1.3.4.

D.1.3.1 Laboratory Performance Criteria

The following sections provide descriptions of procedures to be followed for evaluation of the laboratory performance criteria.

GC, GC/MS, ICP, ICP-MS, CVAA and GFAA Analyses

A minimum of 10 percent of the data packages from each laboratory for the ICP, ICP-MS, CVAA and GFAA metals will be reviewed for the following laboratory performance criteria using guidance from the Functional Guidelines as applicable to the analytical method and the provisions of this QAPP:

- Initial calibrations
- Continuing calibration verifications

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- ICP interference check sample results
- Laboratory control sample results
- Result calculations

Ten percent of the data on the summary forms will be checked back to the raw data for potential transcription errors and data transfer errors. If significant or systematic errors are found, either the laboratory will be contacted and revised data packages obtained containing corrected information for the whole data package, or 100 percent of the data type for which the error was found will be checked.

For organics by GC or GC/MS, 10 percent of the data packages from each laboratory will be reviewed using guidance from the Functional Guidelines as applicable to the analytical method for instrument performance checks, initial and continuing calibrations, and compound quantitations. The QC limits specified in this QAPP or in the analytical methods will replace the Control limits in the Functional Guidelines for validation. If there is a QC sample or measure specified in the Functional Guidelines that is not required when using a given analytical method, the response by the validator will be "not applicable". If a validation question in the Functional Guidelines refers to similar processes in the analytical method with somewhat differing protocols, such as calibration requirements, the validation question will be evaluated and answered with respect to the analytical method requirements.

Radiological Analyses

For radiological parameters, 10 percent of the data packages from each laboratory will be reviewed using guidance from the SAIC document Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses, Revision 05A, as applicable to the analytical method for the following laboratory performance criteria.

- Initial calibration
- Continuing calibration verifications/efficiency calibrations
- Laboratory control sample results
- Chemical separation specificity
- Systems performance
- Reported result calculations

Other Analyses

A minimum of 10 percent of the data packages from each laboratory for other analyses will be reviewed for the applicable portions of the following laboratory performance criteria:

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Data Validation and Usability

- Evaluation of calibration and tuning information to determine compliance with specifications contained within the individual methodologies. Data may be qualified as estimated "J" (or rejected "R" if in the professional judgement of the validator, the data are unusable).
- Evaluation of spike recoveries (control sample spikes) with data outside of the accuracy limits specified in Section B.4 of this QAPP or in the analytical methods qualified as estimated, "J" (or rejected, "R," if in the professional judgment of the validator the data are unusable).
- Evaluation of compound quantitation with recalculation of values from the raw data for ten percent of the data packages. If problems are found, additional data calculations will be checked or the laboratory will be contacted and revised data packages obtained.

D.1.3.2 Sample-Specific Criteria

All of the data packages for each analysis type from each laboratory will be reviewed for the sample-specific criteria described in the sections below. In addition to the specific criteria noted below, the reviewer will investigate the effect of any systematic problems noted in the review of the laboratory performance criteria and of any problems noted by the laboratory in the Case Narrative and will qualify the data where appropriate. No recalculation of results from the raw data or transcription error checking will be performed during the review of the sample-specific criteria.

Initial Data Review

Data package reports will be compared with appropriate chain-of-custody forms to ensure the following.

- The samples and analyses specified on the chain-of-custody form and in the analytical report are consistent with samples and analyses specified in the SAP.
- The samples were preserved and transported as specified in the QAPP.
- The laboratory received the samples in adequate condition (e.g., 4°C).
- The date and time sampled listed in reports agrees with that listed on the chain-of-custody form.

Field Duplicate Precision

Criteria for evaluating field duplicate results are not provided in the Functional Guidelines. Therefore, the following criteria will be used for validation of field duplicate results for all non-radiological analyses. Field duplicate precision for radiological analyses will be evaluated using guidance from the Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses. Where both the sample and duplicate values are greater than 5 times the sample quantitation limit (SQL), acceptable sampling and analytical precision is indicated by an relative percent difference (RPD) for the two field duplicate results of less than or equal to 50 percent (30 percent

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for aqueous samples). Where one or both of the field duplicate pair analytes are less than 5 times the SQL, satisfactory precision is indicated if the field duplicate results agree within 3.5 times the SQL (2 times for aqueous samples). In the case where one or both of the field duplicate pair analytes are not detected, the non-detect sample quantitation limit shall be used in the calculation to assess precision. If the above criteria are not met for an analyte, qualify all associated sample data for that analyte as estimated (“J”).

GC, GC/MS, ICP, ICP-MS, CVAA and GFAA Analyses

Metals data from ICP, ICP-MS, CVAA or GFAA analyses will undergo evaluation from the reported results for the following sample-specific criteria utilizing guidance from Functional Guidelines and the criteria from Section B.4 of this QAPP:

- Holding times
- Blanks
- Duplicate sample analysis
- Matrix spike sample analysis
- Graphite furnace atomic absorption QC
- ICP serial dilutions
- Field duplicate result agreement

For organics by GC or GC/MS, the data will be evaluated from the reported results utilizing guidance from Functional Guidelines and criteria specified in Section B4 of this QAPP for holding times, blanks, surrogate spike results, matrix spike/matrix spike duplicate analyses, target compound identification, tentatively identified compounds, and field duplicate result agreement.

Radiological Analyses

Radiological data will undergo evaluation from the reported results for the following sample-specific criteria utilizing guidance from Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses and the criteria from Section B.4 of this QAPP as applicable for a given method.

- Holding times
- Blanks
- Duplicate sample analysis
- Matrix spike sample analysis
- Target radionuclide list identification
- Field duplicate result agreement

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Other Analyses

Data validation will consist of the applicable portions of the following as defined by the QA provisions contained in this QAPP and in the analytical methodology:

- Evaluation of compliance to holding time limits, with data outside of the holding time limits specified in Section B.4 qualified as estimated (or rejected if in the professional judgment of the validator the data are unusable).
- Evaluation of spike recoveries (matrix spikes) and duplicate analysis precision (field duplicates, matrix spike duplicates, or laboratory duplicates) with data outside of the accuracy and precision limits specified in Section B.4 qualified as estimated, "J" (or rejected, "R," if in the professional judgment of the validator the data are unusable).
- Evaluation of field blank contamination with qualification of data from samples associated with contaminated blanks using the following guidance adapted from Functional Guidelines.

Blank Contamination

Action in the case of unsuitable blank results depends on the circumstances and origin of the blank. No positive sample results should be reported unless the concentration of the analyte in the sample exceeds five times the amount (in any blank). In instances where more than one blank is associated with a given sample, qualification should be based upon a comparison with the associated blank having the highest concentration of a contaminant. The results must not be corrected by subtracting any blank value. Specific actions are as follows:

1. If a compound is found in a blank, but not found in the sample, no action is taken.
2. If a blank has a positive result for an analyte, qualify associated sample data as follows:

If the sample result is greater than the laboratory sample quantitation limit but less than 5 times the blank concentration, flag the sample result as a non-detect ('U'). If the sample result is reported as detected at a concentration less than the quantitation limit and less than 5 times the blank concentration, qualify the sample result as not-detected at the laboratory sample quantitation limit. If the sample result is greater than or equal to 5 times the blank concentration, no action is taken. For aqueous blanks applied to soil/sediment samples, qualification is assigned based on comparison of the sample result to the equivalent concentration of the blank. The equivalent concentration is determined by assuming that all of the analyte present in the blank aliquot analyzed is present in the sample aliquot analyzed.

The reviewer should note that the blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. These factors must be taken into consideration when applying the 5 x criteria, such that a comparison of the total contamination is actually made.

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D.1.3.3 Documentation

Data review procedures will be documented through completion of method-specific checklists prepared from the preceding lists. The checklists will also document any nonconformances and provide an explanation for the assignment of data qualifiers. Completed checklists will be signed and dated by the reviewer, reviewed by the Project QA Manager, and filed with the analytical reports.

D.1.3.4 Flagging Conventions

All data, with the exception of the radiochemical data, will be validated and qualified using guidance from the U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (February 1994b) and Organic Review (February 1994c). The radiochemical data, will be validated and qualified using guidance from the SAIC document Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses (April 1993).

The following flags will be used to qualify the data as necessary.

- J: The associated numerical value is an estimated quantity.
- NJ: The analysis indicates the presence of an analyte that has been tentatively identified, and the associated numerical value represents its estimated concentration.
- N: Presumptive evidence that the analyte is present, but the result was not confirmed.
- R: The data are unusable (analyte may or may not be present)
- U: The analyte was analyzed for, but not detected above the method detection limit. The associated numerical value is the method detection limit.
- UJ: The analyte was analyzed for, but not detected above the method detection limit; the associated quantitation limit and method detection limit are considered as estimated values.
- DL: Detection limit requirements not met. Data quality objectives may not be met (radiochemistry only).
- JE: Uncertainty is an estimated quantity. This estimated flag applies only to the uncertainty and has no reflection on the quality of the result (radiochemistry only).

D.2 VALIDATION AND VERIFICATION METHODS

Data verification and validation will be completed at the frequency specified in Section D.1 using the guidance documents specified in Section D.1. An organizational chart for verifying and validating data is presented in Figure D.2-1. The Project QA Manager is responsible for receiving data from the analytical laboratories, assigning qualified data reviewers/validators, and reviewing completed data review/validation checklists. Data reviewers/validators are responsible for completing data review/validation checklists, assigning data qualifiers, tabulating results, and communicating nonconformances to the Project QA Manager. The data

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reviewer/validator will notify the Project QA Manager of any nonconformance revealed in the data review or validation. The Project QA Manager will be responsible for communicating the nonconformance and the corresponding corrective action to the laboratory and the Project Manager.

D.3 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Once the data verification and validation procedures have been completed, the Project QA Manager will evaluate the results to determine if project DQOs have been met. Both the analytical results and actual sampling procedures will be evaluated. The Project QA Manager will be responsible for preparing a DQA report as described in Section C.1.2, and transmitting the DQA report to the URSG Project Manager. The following tools may be used in evaluating the results against project DQOs. Additional discussion of these tools is included in Section A.7.

D.3.1 Precision

Precision examines the spread of data about their mean. The spread represents how different the individual reported values are from the average reported values. Precision is thus a measure of the magnitude of errors and will be expressed as the Relative Percent Difference (RPD) or the relative standard deviation (RSD) for all non-radiochemistry methods. For radiological constituents, an RPD between a sample and its duplicate will not be calculated. Rather, the Duplicate Error Ratio (DER) will be used to evaluate duplicate precision. The DER takes into account both the sample value and the sample value uncertainty as necessary for radiological results. The lower these values are, the more precise are the data. These quantities are defined as follows:

$$\text{RPD (\%)} = 100 \times \frac{|S - D|}{(S + D)/2}$$

$$\text{RSD (\%)} = (s/X) \times 100$$

$$\text{DER} = \frac{|S - D|}{\sqrt{U_S^2 + U_D^2}}$$

where:	D	=	Concentration or value of an analyte in a duplicate sample
	S	=	Concentration or value of an analyte in a original sample
	X	=	Mean of replicate analyses
	s	=	Standard deviation
	U _S	=	Estimated 1-sigma total random error associated with S
	U _D	=	Estimated 1-sigma total random error associated with D

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For radiological parameters, if the total uncertainties U_i for the measured concentrations S_i are unknown, they may be estimated. When duplicate analyses are performed, the total uncertainties may be estimated as follows:

$$U_i^2 = E_i^2 + h^2 \left(\frac{S_1 + S_2}{2} \right)^2$$

where: E_i = Estimated 1-sigma counting error
 η = Maximum acceptable 1-sigma total random error, excluding counting error, expressed as a fraction of the concentration

The result of a duplicate analysis is acceptable if $|\text{DER}| \leq 2$. An investigation is necessary if $2 < |\text{DER}| \leq 3$. Corrective action is required whenever $|\text{DER}| > 3$.

Other applicable means of calculating and evaluating precision thresholds (DER) exist and will be considered as necessary and applicable.

D.3.2 Accuracy

Accuracy measures the average or systematic error of an analytical method. This measure is defined as the difference between the measured value and the actual value. For non-radiological parameters, accuracy will be expressed as the percent recovery. This quantity is defined as follows:

$$\text{Recovery (\%)} = \frac{|\text{SC} - \text{UC}|}{\text{KC}} \times 100$$

where: SC = Measured spiked concentration of an analyte
UC = Measured unspiked concentration of an analyte
KC = Known concentration of an analyte

In the case of a radiological parameter matrix spike, the accuracy indicator is defined as

$$Z_r = \frac{S - B - K}{\sqrt{U_s^2 + U_b^2 + U_k^2}}$$

where: S = Measured concentration in spiked aliquot
B = Measured concentration in unspiked aliquot
K = Known concentration of spike added
 U_s = Estimated 1-sigma total random error associated with S
 U_b = Estimated 1-sigma total random error associated with B
 U_k = Estimated 1-sigma total uncertainty associated with K

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The total random uncertainties U_s and U_b may be estimated as follows:

where: E_s = Estimated 1-sigma counting error for S

$$U_s^2 = E_s^2 + \eta^2 S^2,$$

$$U_b^2 = E_b^2 + \eta^2 B^2,$$

E_b = Estimated 1-sigma counting error for B

η = Maximum acceptable 1-sigma total random error, excluding counting error, expressed as a fraction of the concentration

The accuracy indicator for radiological parameter performance spikes and radiological parameter standard reference materials is defined as

$$Z_r = \frac{S - K}{\sqrt{U_s^2 + U_k^2}},$$

where: S = Measured concentration of reference material

K = Known concentration of reference material

U_s = Estimated 1-sigma total error associated with S

U_k = Estimated 1-sigma total uncertainty associated with K

The total random uncertainty U_s may be estimated as follows:

$$U_s^2 = E_s^2 + \eta^2 K^2,$$

where: E_s = Estimated 1-sigma counting error for S

η = Maximum acceptable 1-sigma total random error, excluding counting error, expressed as a fraction of the concentration

It is permissible to use a fixed percentage of K, not to exceed 5%, for U_k . If the uncertainty in K is assumed to be negligible, then U_k may be set equal to zero.

The indicator is acceptable if $|Z_r| \leq 2$. An investigation is necessary if $2 < |Z_r| \leq 3$. Corrective action is required if $|Z_r| > 3$.

When required for radiological parameters, NAREL will compute and report the "percent recovery", or %R, which is given by

$$\%R = \frac{S - B}{K} \times 100\%$$

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for matrix spikes and by

$$\% R = \frac{S}{K} \times 100\%$$

for performance spikes and standard reference materials. Acceptance criteria for %R generally require spiked activities significantly higher than environmental levels.

D.3.3 Completeness

Completeness establishes whether a sufficient amount of valid measurements were obtained. The closer this value is to 100, the more complete the measurement process. The overall project analytical completeness goal is 80%; similarly, the overall definitive data and screening data analytical completeness goals are 80% each. Completeness will be calculated as follows:

$$\text{Completeness (\%)} = \frac{V}{R} \times 100$$

where: V = Number of valid measurements (includes data qualified as estimated)

 R = Number of requested measurements

D.3.4 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent the environmental condition. Representativeness is achieved in part through using standard sampling and analytical procedures described in this QAPP and supporting SAP (Appendix A). Representativeness is also influenced by appropriate program design and such elements as proper well locations, drilling and installation procedures and sampling locations. Program design is documented in the QAPP and SAP which is reviewed by data users and approved by EPA representatives to further assure that all representativeness issues are addressed.

Colocated field duplicates will be used to evaluate how representative a sample collected is of a sample location. Laboratory or method duplicates will be used to evaluate how representative an aliquot taken from a sample is of a given sample. Following a determination of precision, a statement on representativeness will be prepared noting the degree to which data represents the environment.

D.3.5 Comparability

Comparability expresses the confidence with which one set of data can be compared to another. Following the determination of both precision and accuracy, a statement on comparability will be prepared in relation to use of the data sets in further evaluations and modeling of the environmental and contaminant conditions under investigation. A statement on comparability will also be prepared when the data collected are used with data reported from another study.

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D.4 ADDITIONAL DATA QUALITY ASSESSMENT

In addition to the reconciliation with data quality objectives described above, data reviewers will also assess the comparison of total and dissolved metal concentrations and the cation-anion balance for groundwater and surface water samples as discussed in Section B.5.2.

D.4.1 Comparison of Total and Dissolved Metals Concentrations

If a dissolved metal concentration exceeds a total metal concentration, the RPD will be calculated as follows:

$$\text{RPD (\%)} = 100 \times \frac{D - T}{(D + T)/2}$$

where: D = dissolved concentration
T = total concentration

Calculated RPDs exceeding 10% may result in both total and dissolved metal results being qualified as “J”, estimated.

D.4.2 Cation-Anion Balance

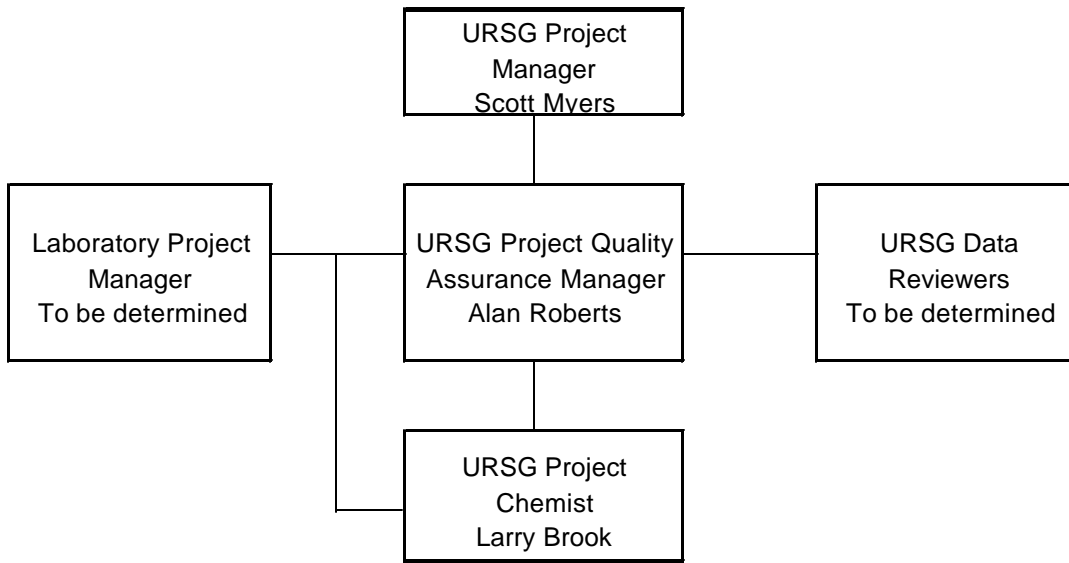
The cation-anion balance will be calculated using the following ratio for samples where the sum of the dissolved cation concentrations exceed 100 mg/l and the sum of the anion concentrations exceed 100 mg/l.

$$\text{RATIO} = \frac{-(C)}{(A)}$$

where: C = sum of the cation charge equivalents
A = sum of the anion charge equivalents

Calculated ratios exceeding a 0.9 – 1.1 acceptance range may result in both cation and anion results being qualified as “J”, estimated.

Figure D.2-1
ORGANIZATIONAL CHART FOR VERIFYING AND VALIDATING DATA



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Appendix A

Sampling and Analysis Plan

AppendixA

Sampling and Analysis Plan

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AppendixA

Sampling and Analysis Plan

1.0 INVESTIGATION APPROACH

The Midnite Mine Phase 1A RI/FS field investigation is being conducted to collect environmental data to satisfy the data needs identified in the Quality Assurance Project Plan (QAPP). The data needs were identified during the data quality objective (DQO) process, which was implemented to clearly and unambiguously define project objectives, decisions, and decision criteria. The approach to the field investigation is described below.

The field investigation has been designed to collect data to:

- Determine whether PCOCs have migrated from the MA to the PIA in groundwater, surface water, or sediment.
- Evaluate the nature and extent of contamination in groundwater, surface water, or sediment in the PIA, if present, to quantify the risk to human health and the environment.
- Support evaluation of remedial alternatives for PIA groundwater, surface water, or sediment.
- Characterize background levels of naturally-occurring PCOCs in groundwater, stream surface water, and stream sediments.

The following tasks will be performed during the Phase 1A field investigation to collect the additional data necessary for the RI/FS evaluation:

- Installation of groundwater monitoring wells in the PIA and background areas.
- Groundwater sampling at new and existing wells in the PIA, and new background wells.
- Sampling of seeps at the boundary between the MA and the PIA.
- Sampling of surface water and sediment in the PIA and background areas.
- Measurement of hydraulic heads and surface water flow rates in the PIA and at background areas.
- Laboratory analysis of groundwater, surface water, and sediment samples for metals, radionuclides, other inorganic constituents, and, in some PIA areas, organic constituents.

These tasks and supporting activities are described in remaining sections of this Sampling and Analysis Plan (SAP).

2.0 FIELD ACTIVITIES

This section describes field activities that will be performed for the Midnite Mine Phase 1A RI/FS field investigation. Phase 1A involves investigation of the PIA and background areas and consists of the following activities:

Appendix A

Sampling and Analysis Plan

- Premobilization
- Laboratory procurement
- Mobilization
- Borehole drilling
- Borehole geophysical logging
- Groundwater monitoring well installation and development
- Groundwater sampling
- Groundwater level measurement
- Surface water (including seeps) and sediment sampling
- Sample management
- Decontamination
- Management of investigation derived waste (IDW)
- Surveying
- Demobilization

Instructions for performing the field activities are given in standard operating procedures (SOPs), which are included in Appendix B. Many of the SOPs are based on written procedures presented in the Work Plan for the Midnite Mine prepared by SMI (SMI 1998). Certain procedures were added or modified to satisfy the data collection needs for the Phase 1A RI/FS.

Field audits, as described in the QAPP, will be performed to ensure that approved methods and procedures are followed during the field investigation. Any identified deviations from this SAP or SOPs will be documented, and the URSG Project Manager, URSG Site Manager and URSG Project Quality Assurance Manager will be informed. Procedures for corrective actions are described in the QAPP.

2.1 Premobilization

Prior to the start-up of field activities, the site will be visited to perform field reconnaissance of proposed sample locations. The proposed monitoring well and groundwater sample locations shown on Figure A.7.2-9 (PIA) and Figure A.7.2-11 (background areas) are approximate. The proposed locations were selected for this SAP without the benefit of visiting the proposed field locations. The locations will be selected and staked during field reconnaissance based on the following information:

- Site access
- Local topography

Appendix A

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- Availability of water and sediments (surface water and sediment sampling locations)
- DQOs for the sample points

It may be necessary to perform earthwork to provide adequate access for drilling of certain boreholes and well installation. The need for any earthwork will be identified during the premobilization activities so that the Site Manager can coordinate the work with other field activities.

The selected monitoring well and sample locations will be staked and marked for future field activities. The URSG Project Manager will be informed if no suitable location for a proposed sampling point can be identified. The URSG Project Manager will then be responsible for the re-evaluation of the sample point, and identifying an alternative location to meet the related data needs.

Additional premobilization activities may include identifying appropriate locations for a field trailer and decontamination facilities, and making arrangements for electric power for the field trailer and other logistic considerations.

Ordering of equipment and supplies will occur during the premobilization. Contracting of subcontractors will also be conducted during this period.

2.2 Mobilization

Mobilization activities will be conducted to prepare field personnel and the field activities support area for the start-up of work. Mobilization will involve the following activities:

- Set-up of field trailer and decontamination facilities on the site
- Receipt, organization, and transport of field supplies and equipment
- Calibration and testing of field equipment
- Set-up and checking of site communications
- Kick-off meeting involving field staff, members of the technical working group, and supporting office staff
- Site health and safety briefing

2.3 Borehole Drilling

A total of 56 borings will be drilled as part of the Phase 1A RI/FS field investigation for the purpose of constructing monitoring wells; 36 in the PIA and 20 in background areas. As part of premobilization activities (Section 2.1), each proposed boring location will be staked and marked. If the drilling crew identifies access or other problems with a marked boring location, the URSG Site Manager will be contacted. The location of each boring will be documented by surveying the location after monitoring well completion.

Appendix A

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A list of the proposed monitoring wells for the PIA is presented as Table A-1. The approximate well locations are shown on Figure A.7.2-9. The table indicates the proposed well type and the approximate target depths of the wells. Two of the proposed PIA wells are to be completed in saturated unconsolidated material. These wells are referred to as alluvial water table wells. Nineteen of the PIA wells are to be completed in the uppermost water-bearing zone (i.e., first water) within bedrock. The remaining 15 PIA wells are to be completed in bedrock, deep (i.e., approximately 100 to 200 feet) below the water table.

Proposed background wells are described in Table A-2. The approximate well locations are shown on Figure A.7.2-11. The table indicates the proposed well type and the approximate target depths of the wells. Ten of the background wells are to be completed in alluvium. Seven of the wells are to be completed in the uppermost water-bearing zone within bedrock. The remaining three wells are to be completed in bedrock deep below the water table.

Alluvial wells are planned to be drilled using hollow-stem augers. These wells will be drilled through the alluvium into the top of bedrock. In the event that drilling problems occur using hollow stem augers, it may be necessary to use bedrock drilling methods described below to complete alluvial boreholes.

The bedrock borings will be drilled using casing advance reverse circulation dual tube drilling rigs. Casing will be advanced through unconsolidated material (alluvium or weathered bedrock) to provide stability in the borings during drilling and well installation. Once the hole is considered to be stable, drilling will be continued below the cased portion of the boring as an open hole. The open hole section of the boring will be drilled to the target depth listed on Table A-1 (PIA) or A-2 (background areas), or as field conditions dictate. The open hole section of the boring will then be geophysically logged to help locate fractured zones or other water-bearing features, or in the case of background wells to target mineralized zones. If the targeted characteristics (i.e., water-bearing zone or mineralized zone) are not encountered upon reaching the target depth, the boring will be drilled until the targeted characteristics are encountered to a maximum depth of 100 feet deeper than the target depth. Geophysical logging is discussed in Section 2.4 and SOP No. 13 Borehole Geophysical Logging.

Drilling procedures are described in SOP No. 1 Drilling and Sampling of Subsurface Materials. Each of the borings will be visually logged and documented in field logbooks by a rig geologist or engineer in accordance with SOP No. 2 Borehole Logging. An example of the boring log form is provided in Appendix C of the QAPP.

No subsurface materials will be collected for laboratory analysis as part of the Phase 1A RI/FS field investigation. However, in background area bedrock borings, samples of subsurface materials will be archived for possible future analysis. The collection of these samples is described in SOP No. 1. These samples will be subject to the sample handling, shipping, and documentation requirements described in SOP No. 11. The chain-of-custody will not specify the analytical requirements, rather it will only indicate that the sample should be archived.

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Decontamination of downhole drilling and logging equipment will be performed in accordance with SOP No. 10, Decontamination to prevent cross-contamination between boring locations as well as cross-contamination of subsurface units within individual borings.

Soil and liquid waste generated during drilling activities (e.g., drill cuttings and decontamination water) will be handled in accordance with procedures described in Section 2.10.

2.4 Borehole Geophysical Logging

Downhole geophysical logging will be performed to help identify screen intervals for well completion. The well screens in bedrock wells will be placed in fractured zones that are water-bearing, and mineralized zones in some background locations. The types of geophysical logs to be performed include natural gamma, caliper, temperature, and fluid conductance. The choice of logs will be dependent on the characteristics of target zones and objectives of individual wells.

Geophysical logging will be performed in open hole bedrock sections of the borings. The logging will be performed in accordance with procedures described in SOP No. 13 Borehole Geophysical Logging. Personnel performing the geophysical logging will require specialized training in the calibration and use of logging instruments and the analysis of log data.

2.5 Monitoring Well Installation and Development

As described in Section 2.3, three types of monitoring wells will be installed as part of the Phase 1A RI/FS field investigation: alluvial water table wells; bedrock water table wells; and deep below the water table bedrock wells. Well installation is discussed in Section 2.5.1. Development of monitoring wells is discussed in Section 2.5.2.

New monitoring well locations will be surveyed in accordance with SOP No. 14 GPS Surveying following well completion. The survey will include measurement of the location northing and easting in State Plane coordinates, as well as the ground surface and top of well casing elevations. The top of well casing should be surveyed on the north side of the well. This point will serve as the measuring point for subsequent water level measurements and will be clearly marked to facilitate consistency in depth to water measurements.

Waste generated during well installation and development activities will be handled in accordance with procedures described in Section 2.10.

2.5.1 Well Installation

A total of 56 new monitoring wells are planned for the PIA (36 wells) and background area (20 wells) as part of the Phase 1A RI/FS field investigation. The monitoring wells will be constructed in accordance with procedures described in SOP No. 3 Monitoring Well Installation. The new monitoring

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wells will be constructed of 4-inch outer diameter polyvinyl chloride (PVC) well casing. Well construction information will be documented in field logbooks and on well construction logs. An example well construction log is provided in Appendix C.

As described above, three types of wells are proposed: alluvial water table wells; bedrock water table wells; and deep below the water table bedrock wells. The target zones for each proposed well are specified in Tables A-1 (PIA) and A-2 (background areas). The criteria for selecting screen intervals and total well depths vary depending on the type and purpose of individual wells. The well type for each individual well is presented in the well installation tables. Rationale for each of the wells is presented in DQO tables in the QAPP. Information for the three well types is presented in the following subsections.

2.5.1.1 Alluvial Water Table Wells

The general purpose of alluvial water table wells is to monitor groundwater quality in saturated alluvium. In some areas, an additional purpose is to identify the presence of any floating free phase petroleum hydrocarbons in the shallow groundwater. The alluvial wells (PIA and background areas) will be drilled using hollow-stem augers (Section 2.3) through alluvium into the top of bedrock. The wells are proposed to be completed using 15-foot long screen intervals, although it may be necessary to shorten the length of screen if the thickness of alluvium does not allow installation of a well with a screen of that length. The well screens will be placed so that the top of the screen is approximately 5 feet above the static water level. The length of screen above the water table will allow for monitoring of any floating product, as well as allowing for water level rise due to natural seasonal fluctuations. The 10-foot length of screen below the water table allows water level measurements even if the water level drops significantly in response to seasonal fluctuations. Alluvial wells will be constructed of Schedule 40 PVC. Additional well construction details are presented in SOP No. 3 Monitoring Well Installation.

2.5.1.2 Bedrock Water Table Wells

Bedrock water table wells are intended to monitor the uppermost saturated zone in bedrock (i.e., in areas where saturated alluvium is not present). It is unknown whether water will be encountered in weathered bedrock or in fractured unweathered rock. If water table conditions are encountered in weathered bedrock, the static water level should be observable and indicative of the approximate potentiometric surface. If the bedrock is relatively impermeable and flow is controlled by rock fractures, it may be necessary to drill beyond the potentiometric surface (i.e., the depth to which water will rise in the completed well) to encounter the water-bearing fracture. As a result, it may be necessary to drill up to 100 feet below target zones to encounter the uppermost water-bearing zones. This has been observed previously in locations on the mine site, such as the Northwest Ridge.

Borings, in which bedrock water table wells will be installed, will initially be drilled to the target depths (Tables A-1 and A-2) or shallower if water is encountered. If water is encountered, drilling will be

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stopped and, if necessary, borehole geophysical logging will be performed (Section 2.4) to help identify the interval that is producing the water. The well screen will be placed across the first interval in the target zone that produces sufficient quantities of water for sampling. If a significant quantity of water is not encountered, the rig geologist may direct the drillers to discontinue drilling and allow the borehole to stand over night to allow water to enter the boring. It may require drilling to greater depth to locate a water-bearing zone. These wells may be drilled up to 100 feet below the target depth to find water. Additional borehole geophysical logging may be performed to help identify water-bearing zones, in the event that water is encountered. More detail regarding the identification of screen intervals is provided in SOP No. 3 Monitoring Well Installation and SOP No. 13 Borehole Geophysical Logging.

The bedrock water table wells will be completed with 20-foot long factory slotted PVC well screens. The screens will be placed across water-bearing intervals. Bedrock water table wells will be constructed of Schedule 80 PVC. Additional well construction details are presented in SOP No. 3 Monitoring Well Installation.

2.5.1.3 Bedrock Wells Deep Below the Water Table

Deep bedrock wells will be installed to provide information related to: (1) vertical hydraulic gradients within bedrock or between bedrock and alluvium; (2) groundwater quality in deep bedrock flow paths; or (3) background groundwater quality within or downgradient of deep mineralized zones. These wells will be initially drilled to the target depths identified in Tables A-1 (PIA) and A-2 (background areas). The target zones for deep bedrock wells may be associated with specific mineralized zones, or may be intended to evaluate conditions approximately 100 feet below the expected potentiometric surface of the uppermost water-bearing zone. In either case, water may be encountered in a boring before a target zone is reached. Because a column of water from fractures shallower than the target zone may be present in the boring, it may not be possible to identify deeper water-bearing zones based on observations of water inflow to the borehole. Therefore, borehole geophysical logging (Section 2.4) will be performed to aid in identification of deeper bedrock water-bearing zones. If no discernable fractures or other evidence of deep water-bearing zones are observed, the boring will be drilled deeper, to a maximum depth of 100 feet greater than the target depth. Additional borehole geophysical logging will then be performed to attempt to identify water-bearing zones. More detail regarding the identification of screen intervals is provided in SOP No. 3 Monitoring Well Installation and SOP No. 13 Borehole Geophysical Logging.

The deep bedrock wells will be completed with 20-foot long factory slotted PVC well screens. The screens will be placed across water-bearing intervals. The deep bedrock wells will be constructed of Schedule 80 PVC. Additional well construction details are presented in SOP No. 3 Monitoring Well Installation.

2.5.2 Well Development

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Following installation of monitoring wells, the new wells will be developed to remove any potable water introduced to the well during construction and to allow future collection of groundwater samples that are representative of the screened water-bearing zone. Well development will be conducted in accordance with SOP No. 4 Monitoring Well Development. Prior to initiating the development process, a grab sample of the water in the well will be collected and tested for field parameters as described in SOP No. 7 Field Parameter Measurements. Additional grab samples will be collected throughout well development and field parameter measurements will be made until the well has been successfully developed. The well will be considered successfully developed when field parameter values are stable (i.e., they meet the criteria for consistency described in SOP No. 4).

The well development process will be documented in field logbooks and on the well development log. An example log is provided in Appendix C.

Any downhole equipment used during the well development process will be decontaminated as described in SOP No. 10 Decontamination. Purge water and other IDW generated during well development will be containerized and managed as described in Section 2.10.

2.6 Groundwater Sampling

As part of the Phase 1A RI/FS field investigation, groundwater samples will be collected once during expected low flow conditions (fall), and two additional times during spring-early summer. The groundwater samples will be collected at 52 new monitoring wells, including 32 PIA and 20 background area wells, 9 existing PIA wells, and 3 PIA seep locations. Sampling locations and analytical parameters for groundwater samples to be collected in the PIA are listed on Table A-3. Groundwater samples will not be collected at four of the new PIA monitoring wells. Water level measurements will be made at these wells (MWCD-03, MWNW-05, MWWD-02, and MWWD-03) for the purpose of collecting data that will demonstrate whether or not groundwater flow gradients mimic ground surface topography. Background sampling locations and analytical parameters are listed on Table A-4. Groundwater sampling locations for the PIA and background areas are presented in Figures A7.2-9 and A.7.2-11, respectively.

As described in Section 2.7 and SOP No. 5 Monitoring Well Water-Level Measurement, the static water level in monitoring wells will be measured prior to sampling or other activities that could potentially affect the water level. Purging of well water will then be conducted to remove well bore storage so that groundwater samples are representative of the screened formation. Procedures for well purging are described in SOP No. 6, Groundwater Sampling.

Well purging will be performed using a stainless steel/Teflon submersible pump capable of low and high flow rates. An in-line multi-parameter measurement device will be installed in the tubing connected to the pump. Field parameter measurements will be taken during the purging process (SOP No. 7 Field Parameter Measurements). Well purging will be attempted at a low flow rate (0.5 liters/minute). Water

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level measurements will be taken during the purging process to observe any water level changes that occur. If the water level does not drop significantly (i.e., more than 0.1 meters [0.3 feet]) due to low-flow purging, purging of the well will continue at the low flow rate until field parameter (pH, specific conductance, turbidity, and temperature) stabilization is achieved (per SOP No. 7). If the water level drops significantly from the initial static level at the 0.5 l/minute flow rate, the pump rate should be reduced, but no lower than 0.1 l/minute (EPA, 1996). If the stress (drawdown) on the well continues, low flow well purging will be discontinued and the well will be purged at a higher pumping rate or using the bailing method. Pumping at the higher flow rate may result in pumping the well dry. If this occurs, the well should be sampled when the well has recharged sufficiently to collect the sample. Otherwise, the well should be purged until field parameter stabilization is achieved.

Following well purging, field parameters representative of the groundwater sample to be collected will be measured and recorded. Certain field parameters (Eh, pH, specific conductance, dissolved oxygen and temperature) will be measured using the in-line multi-parameter device. The remaining field parameters (ferrous iron, turbidity) will be measured in a grab sample.

Groundwater samples will then be collected in accordance with SOP No. 6 Groundwater Sampling. The samples will be collected using low flow pumps constructed of stainless steel and teflon. Filtered and unfiltered samples will be collected.

Seep (groundwater) samples will be collected following the procedures for collection of surface water samples (SOP No. 8, Surface Water Sampling). Filtered and unfiltered samples will be collected. Field parameter measurements (pH, specific conductance, temperature, turbidity, dissolved oxygen, Eh, ferrous iron) will be made on a grab sample from the specified seep sampling locations or if flow is sufficient, the in-line multi-parameter meter described in SOP No. 7 Field Parameter Measurements may be used.

Samples will be handled as described in Section 3.0 and SOP No. 11 Sample Handling, Shipping, and Documentation and submitted to an analytical laboratory for analysis. Analytical requirements, listed by chemical group, for groundwater samples are presented in Tables A-3 (PIA) and A-4 (background areas) by well location. Specific analytical parameters and analytical methods for each chemical group are presented in Tables B.4.4-2a through B.4.4-2g and Tables B.4.4-3a through B.4.4-3c of the QAPP. Sample containers and preservatives are presented in Table B4.3-1 of the QAPP. The details of each groundwater sampling event will be recorded in field logbooks and groundwater sample field data sheets. An example field data sheet is provided in Appendix C.

Decontamination of any non-dedicated sampling equipment will be performed as described in SOP No. 10 Decontamination. To the degree possible, dedicated sampling equipment such as tubing will be used to minimize the need for equipment decontamination and potential for cross-contamination of wells. Wash water from decontamination, purge water, and any other waste water will be managed as described in Section 2.10.

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2.7 Groundwater Level Measurement

Depth to water will be measured in borings during drilling, and in all monitoring wells as part of each groundwater sampling event and during site-wide rounds of groundwater level measurements. During groundwater sampling events, depth to water measurements shall be made prior to any well purging or sampling activities that may affect the static water level.

The site-wide water level measurement rounds will be performed five times. Three of the water level events will precede groundwater sampling events (once in fall and twice in spring). The other two events will be performed in winter (once) and summer (once) to supplement the other seasonal data. The water levels will be measured at all new and existing monitoring well locations in the MA and PIA. Each round of water level measurements should be completed within a period of no more than one week. The water level data will be used to evaluate hydraulic gradients and for development of potentiometric surface maps. The water level measurements will be recorded in field logbooks and on water level measurement forms. An example form is included in Appendix C of the QAPP.

Water level measurements will be taken and recorded in accordance with SOP No. 5 Monitoring Well Water-Level Measurements. The recorded depth to water values will be subtracted from surveyed measuring point elevations to calculate the groundwater elevations. The depth to water values will be recorded in field logbooks, boring logs, and groundwater sampling field sheets, as applicable.

It is important for measured water levels to be representative of static conditions in the monitoring wells. Sufficient time should be given to allow water levels in new monitoring wells to stabilize following development or other activities. In addition, the quarterly rounds of water level measurements should be coordinated with other field activities occurring at the site (e.g., dewatering of backfilled pits conducted by SMI) to help assure that measurements reflect static water level conditions or other known conditions.

2.8 Surface Water and Sediment Sampling

Impacts to surface water and sediment downstream of the Midnite Mine may exist due to historic operations and present conditions in the MA. To characterize the presence or absence of such impacts, surface water and sediment sampling will be conducted.

Proposed surface water and sediment sampling locations for the PIA are presented in Table A-5 and shown on Figure A.7.2-10. Twenty-seven surface water and 32 sediment sampling locations will be sampled. The surface water locations will be sampled three times; once in the fall, and twice in the spring. Sediment sample locations will be sampled once in the fall. Additional sediment samples will be collected at PIA locations where fall sediment sample chemical concentrations exceed background levels. Fourteen of the surface water locations and 9 of the sediment sampling locations were previously sampled.

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In general, surface water and sediment samples are paired at each sampling location because of the similarity in potential contamination pathways. PIA sample locations were chosen to be located downstream of potential sources so that impacts to water quality and sediment can be defined. For example, surface water and sediment water samples, SWNE-01 and SDNE-01 respectively, are located below the Pit 4 dump in the uppermost reach of the Northeastern Drainage because surface water and sediment flow over disturbed material before entering the drainage.

The rationale for sample locations in the Blue Creek drainage differed from those located closer to the MA. Existing data showed apparently naturally high radionuclide levels in some tributaries to Blue Creek and some examples of increasing constituent concentrations with increasing distance from the MA. Therefore, it is necessary to distinguish Midnite Mine impacts from naturally occurring elevated constituent concentrations or those from other unrelated mining activities. To achieve this objective, samples were located to confirm and further define existing conditions in surface water and sediment in Blue Creek.

Proposed surface water and sediment sampling locations for background areas are presented in Table A-6 and shown on Figure A.7.2-11. Background sampling locations were chosen to target those areas that meet the following criteria:

- Geologically similar to the mine site (i.e., mineralized area)
- Upstream of the mine or in different drainage area
- Undisturbed by mining or other activities
- Reasonably close to the mine
- Similar hydrologic conditions
- Accessible

Because surface water quality may change during the year, water samples will be collected twice during relatively wet (spring) conditions and once during relatively dry (fall) conditions with the purpose of defining maximum constituent concentrations. There is not a conclusive relationship between the magnitude of streamflow discharge and the magnitude of constituent concentrations.

Surface water samples will be collected in accordance with SOP No. 8, Surface Water Sampling. Filtered and unfiltered samples will be collected. In addition, measurements of field parameters (pH, specific conductance, turbidity, Eh, ferrous iron, temperature, dissolved oxygen) will be made in accordance with SOP No. 7 Field Parameter Measurements. Discharge measurement will be made at PIA and background surface water sampling locations in accordance with SOP No. 12, Surface Water Discharge in Streams and Seeps.

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Sediment samples from both PIA and background locations will be collected during the fall season. Additional verification of sediment samples may be collected from PIA locations where chemical concentrations exceed background concentrations.

PIA sediment will be collected as composite samples. At the 16 background sediment sampling locations, both discrete (grab) and composite samples will be collected. Sediment samples will be collected in accordance with SOP No. 9, Sediment Sampling.

Surface water and sediment samples will be handled as described in Section 3.0 and submitted for laboratory analysis. Analytical requirements for samples are listed by chemical group in Table A-5 (PIA) and Table A-6 (background areas). Specific analytical parameters and analytical methods for each chemical group are presented in Tables B.4.4-2a through B.4.4-2g and Tables B.4.4-3a through B.4.4-3c of the QAPP. Sample containers and preservatives are presented in Table B.4.3-1 of the QAPP.

The details of each surface water and sediment sampling event will be recorded in field logbooks and surface water/sediment sampling field sheets. An example field sheet is provided in Appendix C of the QAPP. Decontamination of sampling equipment used in surface water or sediment sampling activities will be performed as described in SOP No. 10 Decontamination. Wash water from decontamination, and any other IDW will be managed as described in Section 2.10.

Surface water and sediment sampling locations will be surveyed in accordance with SOP No. 14, GPS Surveying.

2.9 Decontamination

Decontamination of personnel, sampling equipment, and heavy equipment will be performed during data collection activities for the following purposes:

- Personnel health and safety
- Minimization of cross-contamination of samples and environmental media
- Minimization of migration of contamination to off-site areas

A personnel decontamination facility will be constructed at the site. Personnel will follow procedures for individual decontamination described in SOP No. 10 Decontamination. Use of personal protective equipment (PPE) is described in the Health and Safety Plan. Disposal of used PPE is described in Section 2.10.

Sampling equipment and downhole equipment (e.g., augers, bailers, pumps) will require decontamination between sample locations. If multiple water samples are collected at individual sample locations, sampling equipment will be decontaminated between samples. Procedures for equipment decontamination are presented in SOP No. 10 Decontamination.

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Field vehicles that enter any sampling/drilling location exclusion zones or the MA will be decontaminated before leaving the site. Vehicles and heavy equipment, such as drilling rigs, will be decontaminated at a decontamination facility in the vicinity of Pit 3. Procedures for heavy equipment decontamination are presented in SOP No. 10 Decontamination.

The effectiveness of decontamination procedures will be checked by frisking personnel, sampling equipment, and heavy equipment with a thin window Geiger-Muller detector. Procedures for use of the detector are described in the Health and Safety Plan. The decontamination and frisking procedures will be documented in field logbooks.

2.10 Management of Investigation Derived Waste

IDW generated during the field investigation is expected to include:

- Used PPE and other non-soil solid wastes
- Wash and rinse water from decontamination activities
- Soil cuttings and other soil wastes generated during sampling
- Well development and purged water

The plan for managing used PPE and other non-soil solid waste generated during field activities (e.g., sample handling) is to collect it in plastic trash bags, transport the waste from the Midnite Mine, and dispose of it at the Spokane Waste Energy Plant.

Waste water IDW that is generated and containerized at sample locations will be transported to Pit 3 and disposed of in the pit lake.

Waste soil cuttings and chips generated during drilling operations and other field activities will be drummed. The waste soil drums will be transported from drilling locations, and emptied on the edge of selected existing waste rock or ore stockpiles. The wastes will be dumped in locations where storm runoff flows toward open pit lakes or other locations that will control flow. The wastes will not be dumped in locations from which runoff and suspended sediment can migrate off-site. The suitable location(s) for disposal of soil and rock cuttings will be specified by the Site Manager.

2.11 Surveying

Global positioning system (GPS) surveying and conventional land surveying methods will be used to survey monitoring well, and surface water and sediment sampling locations in the PIA and background areas. One or more base stations will be set up to improve the accuracy of GPS survey measurements due to the remoteness of some locations to be surveyed. The GPS surveying will be performed in accordance with SOP No. 14 GPS Surveying. The SOP is a general discussion of methods and surveying criteria. It is anticipated that the surveying will be performed by an experienced contractor

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that is knowledgeable of specific GPS surveying techniques. The contractor will be a licensed surveyor in the State of Washington. It is anticipated that the surveying method selection will be based on conditions encountered in the field and accuracy requirements.

Northing and easting coordinates will be reported in the Washington North Zone State Plane Coordinate System. Elevations will be reported in the NAD27 system (using Geoid 96 derived elevations).

2.12 Demobilization

Demobilization will involve the following:

- Dismantling and removal of temporary structures (e.g., field trailer) and associated utilities (electrical power)
- Completion of field documentation
- Final shipping of samples
- Decontamination of site-dedicated vehicles and other equipment to be removed from the site
- Return of equipment and supplies
- Clean-up of any areas that may be disturbed by field investigation activities
- Departure from the site

3.0 SAMPLE MANAGEMENT

Groundwater, surface water, and sediment samples will be collected and submitted to an analytical laboratory as part of the Phase 1A RI/FS field investigation. Sample containers and preservatives are listed in Table B.4.3-1 in the QAPP. Analytical methods are presented in QAPP Tables B.4.4-2a through B.4.4-2g and Tables B.4.4-3a through B.4.4-3c; each table presents methods for one chemical group by individual parameter. Procedures for handling, shipping, and documentation of samples are described in SOP No. 11, Sample Handling, Shipping, and Documentation. The SOP describes chain-of-custody, sample labeling, and sample cooler packing and labeling procedures. Example chain-of-custody forms, sample labels, and sample cooler labels are provided in Appendix C of the QAPP.

As noted in Section 2.3, samples of subsurface material from bedrock borings in background areas will be collected and submitted to an analytical laboratory for archiving and possible future analysis. These samples are subject to the same sample management requirements for other samples. Chain-of-custody forms for these archive samples will indicate that the samples should be archived, rather than specifying analytical requirements.

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Following sample collection, sample containers will be radiologically screened and decontaminated, if necessary, prior to preparing the sample for shipment. The radiological screening process is described in the project Health and Safety Plan. The decontamination process is described in SOP No. 10, Decontamination.

Each sample will be assigned a unique field sample number so that no ambiguity exists in associating sample locations and dates to field measurements and laboratory sample results. The field sample number is the single designation to which laboratory sample analysis results are related. Field crews will be provided with field sample numbers for their planned sampling activities (on pre-printed labels, if possible). QA/QC samples will also be assigned unique field sample numbers.

Field data and investigation activities, including field sample numbers, field parameter measurements, and numerous other types of information will be documented as described in the following section.

4.0 Field Documentation

Field documentation will be performed for the following purposes:

- To track samples
- To associate sample location ID numbers with locations, dates and other sampling event data
- To track the status and completeness of field tasks
- To maintain complete records of sample events and measurements
- To facilitate electronic data entry of field data
- To document the reliability of field instruments
- To provide a written record that can be used to reconstruct field events
- To provide a written record of sample collection, shipment, and custody

Field documentation will include the recording of field events and data in project logbooks, field forms, and completion of chain-of-custody records. Sample locations will be further documented by taking photographs. The procedure for logging photographs to ensure that the photographs are recorded properly is described in SOP No. 11, Sample Handling, Shipping, and Documentation.

The documentation of field data will be used as the primary source of information for the creation of the project database. The field data will be combined with analytical results from laboratories to complete data records. The field data will be the source of information that links the analytical records to the sampling locations and events. Field documents are also the original records of measurements and events. Therefore, it is critical that the field events are recorded accurately and completely.

Field personnel will document all aspects of the investigation activities in project logbooks. The logbook documentation will be the key record of field activities. Complete and accurate descriptions of

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the field activities are critical to the success of the project. Project logbooks should include the following information:

- Date
- Time
- Location
- Weather conditions
- Task
- Level of personal protection
- Personnel present including work crew members and visitors
- Record of events, procedures, and measurements
- Deviations from SOPs (Refer to requirements described in the QAPP)

Field forms will also be used to record field events. Various field forms and their use were introduced in Section 2.0 of this SAP. The purpose of the field forms described in Section 2.0 is to give guidance to field personnel in collection of field data and to create a complete record of the sampling and field measurement events. A list of these forms is provided below:

- Daily quality control report
- Field audit form
- Boring log
- Well construction log
- Well development log
- Monitoring well low-flow purging and sampling form
- Surface water field data sheet
- Surface water flow measurement flow
- Sediment sample collection form
- Water level measurement form

The daily quality control report form is used to summarize field events, and will be filled out daily and submitted to the URSGWC project manager. The boring log form will be used as a guide for creating boring logs in project logbooks. The well construction log and well development log will be completed for each well. The low-flow purging and sampling log may be filled out at the Site Manager's discretion. The groundwater sampling, and surface water and sediment field data sheets should be used as

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checklists to ensure that all relevant data are recorded in logbooks. These forms may be filled out at the Site Manager's discretion. All water level measurements from wells will be recorded on the water level measurement form.

Additional forms will be used to document the sampling activities and provide data records to facilitate the summary of data in the field, provide sample tracking information, and provide a uniform and complete data collection record for computer entry. These forms are integral to the creation of the project database. These forms include:

- Monitoring/sample location summary (Form 11-1A)
- Monitoring/sampling location information form (Form 11-1B)
- Sample collection information form (Form 11-2)
- Field measurement data form (Form 11-3)
- Field data clarification request form (Form 11-4)

Specific instructions for completing these forms are provided with each form. Form 11-1A will be used to document the location ID, location cross-references and other sample location specific information. The location ID is a sequential number that is assigned to sample locations for data management purposes. The location cross-reference is the actual location name as shown in Table A-1 through A-6 and QAPP Figures A.7.2-9 through A.7.2-11.

Form 11-1B is optional and may be used at the project manager's discretion. It can be used for sketches of sample locations. The form may be used in addition to entries in the field logbooks, but it will not be used in place of the logbook documentation.

Form 11-2 shows the sample collection information required for sample tracking. The field sample numbers assigned to collected samples will be indicated on Form 11-2. This form and the chain-of-custody form serve as the link between the field and the laboratory.

Form 11-3 is a record of the field measurement data. All field parameter and streamflow measurements will be recorded on Form 11-3 to facilitate data entry. Form 11-4 is used to clarify any revisions to the sampling event data. Examples of these forms are provided in Appendix C of the QAPP.

5.0 REFERENCES

EPA. 1996. Ground Water Issue: Low-Flow (Minimal Drawdown) Ground Water Sampling Procedures. EPA/540/S-95/504.

Shepherd Miller, Inc. (SMI). 1998. Work Plan for the Midnite Mine. Prepared for Dawn Mining Company. September 28.

APPENDIX A

Sampling and Analysis Plan

Table A-1

**PHASE 1A RI/FS WELL INSTALLATION LOCATIONS
POTENTIALLY IMPACTED AREA**

Location Cross-Reference	Site ID	Target Total Depth (ft-bgs)	Target Zone
MWCD-01	Central Drainage	120	Deep Bedrock
MWCD-02	Central Drainage	110	Deep Bedrock
MWCD-03	Central Drainage	100	Water Table (Bedrock)
MWED-01	Eastern Drainage	25	Water Table (Alluvial)
MWED-02	Eastern Drainage	120	Deep Bedrock
MWED-03	Eastern Drainage	110	Deep Bedrock
MWED-04	Eastern Drainage	110	Deep Bedrock
MWED-05	Eastern Drainage	50	Water Table (Bedrock)
MWED-06	Eastern Drainage	150	Deep Bedrock
MWED-07	Eastern Drainage	50	Water Table (Bedrock)
MWED-08	Eastern Drainage	150	Deep Bedrock
MWED-09	Eastern Drainage	130	Water Table (Bedrock)
MWED-10	Eastern Drainage	20	Water Table (Bedrock)
MWED-11	Eastern Drainage	120	Deep Bedrock
MWFW-01	Far West Drainage	50	Water Table (Bedrock)
MWFW-02	Far West Drainage	150	Deep Bedrock
MWFW-03	Far West Drainage	50	Water Table (Bedrock)
MWFW-04	Far West Drainage	70	Water Table (Bedrock)
MWFW-05	Far West Drainage	70	Water Table (Bedrock)
MWNE-01	Northeastern Drainage	100	Water Table (Bedrock)
MWNE-02	Northeastern Drainage	250	Deep Bedrock
MWNE-03	Northeastern Drainage	150	Water Table (Bedrock)
MWNE-04	Northeastern Drainage	300	Deep Bedrock
MWNE-05	Northeastern Drainage	25	Water Table (Alluvial)
MWNE-06	Northeastern Drainage	120	Deep Bedrock
MWNE-07	Northeastern Drainage	100	Water Table (Bedrock)
MWND-01	Northern Drainage	150	Water Table (Bedrock)
MWNW-05	Northwest Ridge	150	Water Table (Bedrock)
MWNW-07	Northwest Ridge	150	Water Table (Bedrock)
MWSW-01	Southwest Drainage	100	Water Table (Bedrock)
MWSW-02	Southwest Drainage	200	Deep Bedrock
MWWD-01	Western Drainage	110	Deep Bedrock
MWWD-02	Western Drainage	100	Water Table (Bedrock)
MWWD-03	Western Drainage	70	Water Table (Bedrock)
MWWD-04	Western Drainage	20	Water Table (Bedrock)
MWWD-05	Western Drainage	120	Deep Bedrock

APPENDIX A

Sampling and Analysis Plan

Table A-2
PHASE 1A RI/FS WELL INSTALLATION LOCATIONS
BACKGROUND AREAS

Location Cross-Reference	Target Total Depth (ft-bgs)	Target Rock Type	Target Zone	Well Purpose
MWBB-01	50	Togo phyllite	Bedrock Water Table	Sampling of groundwater representative of uppermost water bearing zone.
MWBB-02	50	Quartz monzonite	Bedrock Water Table	Sampling of groundwater representative of uppermost water bearing zone downgradient of Spokane Mountain uranium ore.
MWBB-03	300	Togo phyllite	Deep below the water table	Sampling of bedrock groundwater within zone of Spokane Mountain uranium ore.
MWBB-04	300	Togo phyllite	Deep below the water table	Sampling of bedrock groundwater within zone of Spokane Mountain uranium ore.
MWBB-05	200	Togo phyllite	Deep below the water table	Sampling of groundwater downgradient of Spokane Mountain uranium ore.
MWNW-01 ¹	150	Quartz monzonite	Bedrock Water Table	Assess whether hydraulic gradient from Northwest Ridge is toward the mined area, and if so, sample groundwater upgradient of site.
MWNW-02 ¹	150	Togo phyllite	Bedrock Water Table	Assess whether hydraulic gradient from Northwest Ridge is toward the mined area, and if so, sample groundwater upgradient of site.
MWNW-03 ¹	150	Togo phyllite	Bedrock Water Table	Assess whether hydraulic gradient from Northwest Ridge is toward the mined area, and if so, sample groundwater upgradient of site.
MWNW-04 ¹	150	Quartz monzonite	Bedrock Water Table	Assess whether hydraulic gradient from Northwest Ridge is toward the mined area, and if so, sample groundwater upgradient of site.
MWNW-06 ¹	200	Quartz monzonite	Bedrock Water Table	Assess whether hydraulic gradient from Northwest Ridge is toward the mined area, and if so, sample groundwater upgradient of site.
MWBA-01	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater along tributary of Blue Creek.
MWBA-02	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater along tributary of Blue Creek.
MWBA-03	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater along tributary of Blue Creek.
MWBA-04	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater downgradient of Spokane Mountain along tributary of Blue Creek.
MWBA-05	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater along tributary of Sand Creek where uranium concentrations in sediments appear to be naturally elevated.
MWBA-06	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater downgradient of Spokane Mountain along tributary of Blue Creek.
MWBA-07	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater along tributary of Sand Creek downgradient of Spokane Mountain where uranium concentrations in sediments appear to be naturally elevated.
MWBA-08	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater along tributary of Sand Creek downgradient of Spokane Mountain where uranium concentrations in sediments appear to be naturally elevated.
MWBA-09	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater along tributary of Sand Creek downgradient of Spokane Mountain where uranium concentrations in sediments appear to be naturally elevated.
MWBA-10	25	Alluvium	Alluvial Water Table	Sampling of alluvial groundwater along Sand Creek.

1. Wells MWNW-01 through MWNW-04, and MWNW-06 are also included as PIA wells in the Northwest Ridge area. If, as expected, groundwater elevation data indicate that a hydraulic gradient exists from the ridge toward the mined area, the wells will be considered background wells.

APPENDIX A

Sampling and Analysis Plan

Table A-3
PHASE 1A RI/FS GROUNDWATER SAMPLING LOCATIONS
POTENTIALLY IMPACTED AREA

Location Cross-Reference	Site ID	Location Type	Analytical Parameters ¹
GW-36A	Central Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
GW-51	Central Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MW-2	Central Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWCD-01	Central Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWCD-02	Central Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
GW-19	Central Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
Dam Toe Seep	Central Drainage	Seep	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
East Seep	Eastern Drainage	Seep	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MW-4	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MW-5	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-01	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-02	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-03	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-04	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-05	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-06	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-07	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-08	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-09	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-10	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWED-11	Eastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWFW-01	Far West Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWFW-02	Far West Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWFW-03	Far West Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²

APPENDIX A

Sampling and Analysis Plan

Table A-3
PHASE 1A RI/FS GROUNDWATER SAMPLING LOCATIONS
POTENTIALLY IMPACTED AREA

Location Cross-Reference	Site ID	Location Type	Analytical Parameters ¹
MWFW-04	Far West Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWFW-05	Far West Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNE-01	Northeastern Drainage	Monitoring Well	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNE-02	Northeastern Drainage	Monitoring Well	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNE-03	Northeastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNE-04	Northeastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNE-05	Northeastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNE-06	Northeastern Drainage	Monitoring Well	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNE-07	Northeastern Drainage	Monitoring Well	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNE-01	Northern Drainage	Monitoring Well	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNW-07	Northwest Ridge	Monitoring Well	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWSW-01	Southwestern Drainage	Monitoring Well	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWSW-02	Southwestern Drainage	Monitoring Well	Radionuclides, metals, inorganics, other parameters, rad decay series ²
GW-35A	Western Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
GW-50	Western Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MW-1	Western Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWWD-01	Western Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWWD-04	Western Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
MWWD-05	Western Drainage	Monitoring Well	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²
WDSEEP	Western Drainage	Seep	VOCs, SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ²

1. See Tables B4.4-2a through B4.4-2g for specific analytical parameters and laboratory methods.
2. Radionuclide decay series parameters will be analyzed in water samples from approximately one-third of sample locations in each of the three sampling events. The locations will be selected during the mobilization for sampling. See Tables B4.4-3a through B4.4-3c for analytical methods.

APPENDIX A

Sampling and Analysis Plan

Table A-4
PHASE 1A RI/FS GROUNDWATER SAMPLING LOCATIONS
BACKGROUND AREAS

Location Cross-Reference	Well Type	Analytical Parameters ¹
MWBA-01	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBA-02	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBA-03	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBA-04	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBA-05	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBA-06	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBA-07	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBA-08	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBA-09	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBA-10	Alluvial	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBB-01	Bedrock	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBB-02	Bedrock	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBB-03	Bedrock	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBB-04	Bedrock	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWBB-05	Bedrock	Radionuclides, metals, inorganics, other parameters, rad decay series ²
MWNW-01 ¹	Bedrock	Water Level ³
MWNW-02 ¹	Bedrock	Water Level ³
MWNW-03 ¹	Bedrock	Water Level ³
MWNW-04 ¹	Bedrock	Water Level ³
MWNW-06 ¹	Bedrock	Water Level ³

1. See Tables B4.4-2a through B4.4-2g for specific analytical parameters and laboratory methods.
2. Radionuclide decay series parameters will be analyzed in water samples from approximately one-third of sample locations in each of the three sampling events. The locations will be selected during the mobilization for sampling. See Tables B4.4-3a through B4.4-3c for analytical methods.
3. Wells MWNW-01 through MWNW-04, and MWNW-06 are also included as PIA wells in the Northwest Ridge area. If groundwater elevation data indicate that the wells are hydraulically upgradient of the mined area, the wells will be sampled for the analytical parameters listed for other background wells.

APPENDIX A**Sampling and Analysis Plan****Table A-5****PHASE 1A RI/FS SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
POTENTIALLY IMPACTED AREA**

Location Cross-Reference	Site ID	Location Type	Sample Type	Sample Frequency ¹	Analytical Parameters ²	Other Measurements
BC01SD	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
BC01SW	Blue Creek	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
BC04SD	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
BC04SW	Blue Creek	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
BC05SD	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
BC05SW	Blue Creek	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
BC09SD	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
BC09SW	Blue Creek	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
BC10SD	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
BC10SW	Blue Creek	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SDBC-01	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDBC-02	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SWBC-01	Blue Creek	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
TR04SD	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
TR04SW	Blue Creek	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
TR05SD	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
TR05SW	Blue Creek	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
TR06SD	Blue Creek	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Grain size
TR06SW	Blue Creek	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SDCD-01	Central Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDCD-02	Central Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDCD-03	Central Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SW-12	Central Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SWCD-01	Central Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
ED01SD	Eastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
ED04SD	Eastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
ED-2	Eastern Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
ED-4	Eastern Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
OF01SW	Eastern Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SDED-01	Eastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDED-02	Eastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDED-03	Eastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDED-04	Eastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDED-05	Eastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDED-06	Eastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size

APPENDIX A

Sampling and Analysis Plan

Table A-5
PHASE 1A RI/FS SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
POTENTIALLY IMPACTED AREA

Location Cross-Reference	Site ID	Location Type	Sample Type	Sample Frequency ¹	Analytical Parameters ²	Other Measurements
SEDE-07	Eastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SW-2	Eastern Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SW-6	Eastern Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SWED-01	Eastern Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SWED-02	Eastern Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SDFW-01	Far West Drainage	SED	Composite	1 Fall event	SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SWFW-01	Far West Drainage	SW	Grab	1 Fall, 2 Spring events	SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SDNE-01	Northeastern Drainage	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDNE-02	Northeastern Drainage	SED	Composite	1 Fall event	TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SWNE-01	Northeastern Drainage	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SWNE-02	Northeastern Drainage	SW	Grab	1 Fall, 2 Spring events	TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SDND-01	Northern Drainage	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SWND-01	Northern Drainage	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SDNW-01	Northwest Ridge	SED	Grab, Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDNW-02	Northwest Ridge	SED	Grab, Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDNW-03	Northwest Ridge	SED	Grab, Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SWNW-01	Northwest Ridge	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SWNW-02	Northwest Ridge	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SWNW-03	Northwest Ridge	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SDSW-01	Southwestern Drainage	SED	Composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SWSW-01	Southwestern Drainage	SW	Grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
SDWD-01	Western Drainage	SED	Composite	1 Fall event	SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SDWD-02	Western Drainage	SED	Composite	1 Fall event	SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size

APPENDIX A

Sampling and Analysis Plan

Table A-5

**PHASE 1A RI/FS SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
POTENTIALLY IMPACTED AREA**

Location Cross-Reference	Site ID	Location Type	Sample Type	Sample Frequency ¹	Analytical Parameters ²	Other Measurements
SDWD-03	Western Drainage	SED	Composite	1 Fall event	SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series	Grain size
SWWD-01	Western Drainage	SW	Grab	1 Fall, 2 Spring events	SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow
WDAC	Western Drainage	SW	Grab	1 Fall, 2 Spring events	SVOCs, TPH, radionuclides, metals, inorganics, other parameters, rad decay series ³	Streamflow

1. Additional sediment samples may be collected in the future at some PIA locations to verify sampling results.
2. See Tables B4.4-2a through B4.4-2g for specific analytical parameters and laboratory methods.
3. Radionuclide decay series parameters will be analyzed in water samples from approximately one-third of sample locations in each of the three sampling events. The locations will be selected during the mobilization for sampling. See Tables B4.4-3a through B4.4-3c for analytical methods.

APPENDIX A

Sampling and Analysis Plan

Table A-6
PHASE 1A RI/FS SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
BACKGROUND AREAS

Location Cross-Reference	Location Type	Sample Type	Sample Frequency	Analytical Parameters ¹	Sample Location Purpose
SDBK-01	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample in potentially mineralized area west of Midnite Mine.
SDBK-02	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Confirm results from Blue Creek USGS background sample in which elevated concentrations were observed.
SDBK-03	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample on southeast side of Spokane Mountain downgradient of potentially mineralized area.
SDBK-04	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample on southeast side of Spokane Mountain downgradient of potentially mineralized area.
SDBK-05	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample on southeast side of Spokane Mountain downgradient of potentially mineralized area.
SDBK-06	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample on west side of Spokane Mountain downgradient of potentially mineralized area.
SDBK-07	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample on northeast side of Spokane Mountain downgradient of potentially mineralized area.
SDBK-08	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample on northwest side of Spokane Mountain downgradient of potentially mineralized area.
SDBK-09	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample on northwest side of Spokane Mountain downgradient of potentially mineralized area.
SDBK-10	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample on north side of Spokane Mountain downgradient of potentially mineralized area.
SDBK-11	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample on north side of Spokane Mountain downgradient of potentially mineralized area.
SDBK-12	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Confirm results from Sand Creek USGS background sample in which elevated chemical concentrations were observed.
SDBK-13	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Upstream of USGS background sample in Sand Cr (elevated chemical concentrations) and downstream of Deer Mtn area.
SDBK-14	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample in tributary of Sand Creek where NURE sediment sample results indicate elevated chemical concentrations.
SDBK-15	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample downstream of Deer Mountain mineralized area.
SDBK-16	SED	grab, composite	1 Fall event	Radionuclides, metals, inorganics, other parameters, grain size, rad decay series	Collect sample downstream of Deer Mountain mineralized area.
SWBK-01	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample in potentially mineralized area east of Midnite Mine.
SWBK-02	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Confirm results from Blue Creek USGS background sample in which elevated concentrations were observed.

APPENDIX A

Sampling and Analysis Plan

Table A-6
PHASE 1A RI/FS SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
BACKGROUND AREAS

Location Cross-Reference	Location Type	Sample Type	Sample Frequency	Analytical Parameters ¹	Sample Location Purpose
SWBK-03	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample on southeast side of Spokane Mountain downgradient of potentially mineralized area.
SWBK-04	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample on southeast side of Spokane Mountain downgradient of potentially mineralized area.
SWBK-05	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample on southeast side of Spokane Mountain downgradient of potentially mineralized area.
SWBK-06	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample on west side of Spokane Mountain downgradient of potentially mineralized area.
SWBK-07	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample on northeast side of Spokane Mountain downgradient of potentially mineralized area.
SWBK-08	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample on northwest side of Spokane Mountain downgradient of potentially mineralized area.
SWBK-09	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample on northwest side of Spokane Mountain downgradient of potentially mineralized area.
SWBK-10	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample on north side of Spokane Mountain downgradient of potentially mineralized area.
SWBK-11	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample on north side of Spokane Mountain downgradient of potentially mineralized area.
SWBK-12	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Confirm results from Sand Creek USGS background sample in which elevated chemical concentrations were observed.
SWBK-13	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Upstream of USGS background sample in Sand Cr (naturally elevated chemical concentrations) and downstream of Deer Mtn area.
SWBK-14	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample in tributary of Sand Creek where NURE sediment sample results indicate naturally elevated chemical concentrations.
SWBK-15	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample downstream of Deer Mountain mineralized area.
SWBK-16	SW	grab	1 Fall, 2 Spring events	Radionuclides, metals, inorganics, other parameters, rad decay series ² , streamflow	Collect sample downstream of Deer Mountain mineralized area.

Notes:

SED - sediment

SW - surface water

1. See Tables B4.4-2a through B4.4-2g for specific analytical parameters and laboratory methods.

2. Radionuclide decay series parameters will be analyzed in water samples from approximately one-third of sample locations in each of the three sampling events. The locations will be selected during the mobilization for sampling. See Tables B4.4-3a through B4.4-3c for analytical methods.

Appendix B
Standard Operating Procedures

AppendixB

Standard Operating Procedures

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Drilling and Sampling of Subsurface Materials

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Drilling and Sampling of Subsurface Materials

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SOP NUMBER 1

Drilling and Sampling of Subsurface Materials

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the Standard Operating Procedure (SOP) for drilling of subsurface materials during the Midnite Mine Remedial Investigation/Feasibility Study (RI/FS) field program. This SOP will be used in conjunction with the other SOPs listed below, the Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP).

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager, Site Manager, and designated project staff are responsible for implementing this SOP. All personnel performing drilling procedures are required to have appropriate health and safety training, health monitoring, and supporting documentation as specified in the project Health and Safety Plan (HSP). In addition, all personnel are required to have a complete understanding of the procedures described within this SOP, and will receive training in these procedures, if necessary.

3.0 RELATED STANDARD OPERATING PROCEDURES

The procedures for drilling set forth in this SOP are intended for use with the following SOPs:

- SOP No. 2 Borehole Logging
- SOP No. 3 Monitoring Well Installation
- SOP No. 11 Sample Handling, Shipping, and Documentation
- SOP No. 13 Borehole Geophysical Logging
- SOP No. 10 Decontamination

4.0 EQUIPMENT NECESSARY FOR DRILLING

The following is a list of equipment that will be necessary to perform drilling of subsurface materials:

- Monitoring equipment and personal protective equipment (PPE) as outlined in the site-specific HSP
- Hollow-stem auger (HSA) drill rig with appropriately sized augers and drill rods for drilling in unconsolidated materials
- Reverse circulation drill rig with appropriate sized drill rods and downhole bits/casing systems for drilling in bedrock

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- High pressure, hot water washer for decontamination
- Decontamination equipment and supplies (e.g., wash/rinse tubs, brushes, alconox, plastic sheeting, paper towels, sponges, baby wipes, garden-type sprayers, large plastic bags, potable water, distilled water and/or deionized water)
- Sampling equipment for HSA rig (e.g., stainless steel 2-inch outer diameter split spoon sampler)
- Reclosable plastic bags for archiving samples
- 55-gallon drums or other approved containers for containing soil cuttings

Other materials and equipment may be needed based on field conditions.

5.0 DRILLING PROCEDURES

Prior to drilling, borings will be numbered and the site cleared for utilities. Boring locations may be adjusted in the field due to the presence of underground utilities or other structures, or if access problems are encountered. Drilling locations will be approved by the Site Manager prior to initiating drilling activities.

Health and safety equipment specified in the site-specific HSP will be donned before proceeding with subsurface drilling activities. The HSP will specify action levels for various contaminants and the field monitoring required to measure ambient conditions.

All drill cuttings will be placed in labeled drums and moved to a central secured location for storage. Any water generated during drilling will be contained in labeled drums or tanks. Handling of investigation derived wastes (IDW) will be as specified in the SAP.

Augers and other downhole equipment will be steam-cleaned prior to proceeding to the drill site and between subsequent boreholes using the procedures presented in SOP No. 10 Decontamination. Split-spoon samplers will be decontaminated at the drill site between each sample interval.

All work areas around borings will be restored to a physical condition equivalent to that of pre-drilling, as near as practical. This will include drill cuttings removal and rut repair.

At the direction of the field geologist, only potable water may be introduced into boreholes. No bentonite, barite, polymers, or other additives or viscosifying agents will be introduced into the borehole or used during drilling. It is expected that it will not be necessary to introduce foaming agents into boreholes to lift cuttings during bedrock drilling. However, if the drilling subcontractor suggests that foaming agents are needed, the subcontractor must provide Material Safety Data Sheets (MSDS) for any product that they suggest. The MSDS will then be reviewed by URSGWC to determine if any unacceptable substances are present in the foaming agent before approving its use.

The rig shall be free of leaks that could contaminate the boreholes (i.e., hydraulic fluid, oil, fuel, etc.). Pipe lubricants that are used should not introduce contaminants into the borehole. Lubricants that are

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Drilling and Sampling of Subsurface Materials

environmentally acceptable include Green Stuff[®], King Stuff[®], vegetable oil, Crisco[™], and some Teflon[™]-based lubricants. Lubricants that are not acceptable include petroleum-based and most metal-based lubricants. The Site Manager will pre-approve lubricants that will be used.

5.1 HOLLOW-STEM AUGER DRILLING

The procedures below address drilling of boreholes and collection of subsurface soil samples using a HSA rig. HSA drilling will be conducted to install shallow monitoring wells in unconsolidated materials. Subsurface soil samples may be collected in some boreholes for laboratory chemical analysis at specific intervals as outlined in the project Work Plans. For boreholes where samples are not collected for chemical analysis, samples will be collected at five-foot intervals during drilling and placed in plastic bags. Selected samples from the screened interval will then be shipped to the laboratory and archived for possible future geotechnical and chemical testing.

The following are specific procedures for subsurface drilling and sampling using a HSA rig:

- Remove stones, vegetation, etc., from the sampling location surface.
- Use the appropriate sized augers to provide for a minimum 4-inch annulus around the groundwater monitoring well casing.
- Split-spoon sampling will be performed at five-foot intervals to the total depth of the borehole. The first sample interval will be from 0-2 feet, then 5-7 feet, and so on. The split-spoon sampler will always be advanced ahead of the lead auger to minimize potential cross-contamination.
- Collect a sample by driving the split-spoon sampler using a 140-pound hammer with a 30-inch drop. Record Standard Penetration Test blow counts for each 6-inch interval driven (for the first 18 inches) according to ASTM Method D 1586.
- Bring the sampler to the surface and open the split-spoon sampler.
- Screen the sampled material using the instruments specified in the HSP.
- Log the sample in accordance with SOP No. 2 Borehole Logging.
- If samples are collected, label and handle the sample containers in accordance with SOP No. 11 Sample Handling, Shipping, and Documentation. Place the sample container in a recloseable plastic bag and seal the bag and place the sample in a cooler with ice for shipment.

Repeat the process until the total depth of the borehole is reached.

5.2 REVERSE CIRCULATION DUAL TUBE DRILLING

The procedures below address drilling of boreholes using a reverse circulation dual tube rig. Reverse circulation drilling will be conducted to install bedrock monitoring wells. Samples of drill cuttings will be collected for visual logging purposes at five-foot intervals. At locations specified in the SAP, samples will also be collected and archived for possible future testing.

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Drilling and Sampling of Subsurface Materials

The following are specific procedures for subsurface drilling using a reverse circulation dual tube rig:

- Remove stones, vegetation, etc., from the sampling location surface.
- Install 10-inch steel surface casing to an appropriate depth to stabilize the borehole.
- Convert to down-hole hammer or tricone bit and continue drilling through the surface casing to the desired depth. Use an appropriate drill bit to provide for a minimum 4-inch annulus around the groundwater monitoring well casing.
- Sampling of drill cuttings will be performed at five-foot intervals to the total depth of the borehole. Samples will be collected directly from the cyclone and placed in quart-sized baggies and labeled with the boring number and depth.
- Screen the sampled material using the instruments specified in the HSP.
- Log the sample in accordance with SOP No. 2 Borehole Logging.
- When the total depth of the borehole is reached, the drill rods and bit will be removed and the boring left open to facilitate geophysical logging, as described in SOP No. 13 Borehole Geophysical Logging.
- (At locations identified for archiving of samples) When the screen interval for the well is selected, identify the drill cuttings samples from that interval and save the samples for archiving. Follow sample handling procedures for archiving samples as described in SOP No. 11. Discard the unused samples (i.e., drill cuttings from intervals outside of screened interval) and handle the waste as described in the SAP.

5.3 BOREHOLE ABANDONMENT

Borehole abandonment may be necessary in some cases. The following procedures will be used to abandon boreholes:

- All downhole equipment will be removed from the borehole. Cuttings scraped from the drill rods and bits will be drummed in accordance with the procedures for IDW management in the SAP. Equipment will be decontaminated in accordance with SOP No. 10 Decontamination.
- Boreholes will be grouted using cement-bentonite grout. The grout mix will be in the proportions of one sack of Portland cement (94 pounds), 2 to 5 pounds of powdered bentonite, and approximately 7 to 9 gallons of water. The bentonite will be well mixed with the water prior to adding the cement.
- Grouting will be performed by placing a tremie pipe to the bottom of the borehole and pumping grout through the tremie pipe until undiluted grout flows from the ground surface.
- Twenty-four hours after grouting, the borehole will be checked for settlement and topped off to the ground surface with grout.

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Drilling and Sampling of Subsurface Materials

- Details concerning the abandonment process will be recorded on the boring log and in the field logbook.

6.0 DOCUMENTATION

Project staff are responsible for documenting drilling activities. Information will include borehole location, total depth of borehole, descriptions of drilling equipment used, and other applicable information.

6.1 BORING LOG

A field geologist experienced in borehole drilling will be present at each operating drill rig. This geologist will be responsible for logging samples, monitoring drilling operations, recording water losses or gains and groundwater data, and preparing field boring logs. The procedures for lithologic logging of boreholes is contained in SOP No. 2 Borehole Logging. Boring log information will be recorded in field logbooks.

6.2 SOIL SAMPLE FIELD DATA SHEET

If samples are collected for chemical analysis, sampling activities and observations will be documented on a Soil Sample Field Data Sheet (Appendix C of the QAPP). The soil sample field sampling data sheet will be completed at each sample location. Information on the data sheet will include the following:

- Project name and number
- Field personnel
- Sample number, location, and type
- Sample collection date and time
- Sample depth interval
- Sample color, staining, or odor (describe)
- Monitoring equipment readings (screening and headspace)
- Type of sample containers, sample preservation
- Record of any QA/QC samples collected
- Any irregularities or other problems that may have an impact on sample quality
- Other applicable information

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Drilling and Sampling of Subsurface Materials

6.3 FIELD NOTES

Field notes will be kept during drilling and sampling activities. The following information will be recorded in a bound field log book using waterproof ink:

- Names of personnel at the drill site
- Weather conditions
- Drilling procedures
- Dates and times of drilling and sampling
- Location and borehole identification
- Times that procedures and measurements are completed
- Decontamination times and procedures
- Field instrument calibration information
- Records of visitors to the drill site
- Other applicable information

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Borehole Logging

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Borehole Logging

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Tables

Table 1	Description of Unconsolidated Soil
Table 2	Description of Consolidated Rock

Attachments

Attachment I	Standard Practice for Description and Identification of Soils (Visual Manual Procedure) ASTM D2488-93
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Borehole Logging

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to describe subsurface soil and rock samples during field activities performed at the Midnite Mine Site. This SOP serves as a supplement to the Quality Assurance Project Plan (QAPP) and is intended to be used in conjunction with other SOPs.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

Related SOPs include:

- SOP No. 1 Drilling and Sampling of Subsurface Materials
- SOP No. 13 Borehole Geophysical Logging

4.0 MATERIALS AND EQUIPMENT

The following materials and equipment listed will be needed for borehole logging:

- Boring log forms (Appendix C of the QAPP)
- Waterproof pens
- Hand lens (10X magnification or stronger)
- Metal or wooden tape measure
- Stainless steel knife, screwdriver, rock hammer
- Decontamination equipment and supplies (see SOP No. 10 Decontamination)
- Reference tables listing ASTM and/or Unified Soil Classification System (USCS) codes and descriptions

Other materials and equipment may be needed based on field conditions.

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Borehole Logging

5.0 PROCEDURES

A "site geologist" (geologist, hydrogeologist or geotechnical engineer) experienced in borehole drilling and soil sampling will be present at each operating drill rig. This site geologist will be responsible for logging samples, monitoring drilling operations, recording water losses or gains, and preparing field boring logs. A sample boring log is included in Appendix C of the QAPP. Procedures for completing boring logs are described below:

- Boring log information will be recorded in the field logbook.
- Logs will be prepared in the field by the site geologist as borings are drilled. The preparer will sign each log.
- All log entries will be legibly printed such that photo reproductions will be clear and legible.
- Borehole depth information will be recorded to the nearest 0.1 foot.
- All relevant information in the log heading and log body will be completed. If surveyed horizontal control is not available at the time of drilling, location sketches referenced by measuring distances or prominent surface features shall be shown on, or attached to, the log.
- An appropriate scale will be used on the boring log form (e.g., a scale of 1 inch on the log form equaling 1 foot of boring).
- Each and every material type encountered will be described on the boring log form. Material types will be logged directly from samples and indirectly interpolated using professional judgment, drill cuttings, drill action, etc., between sampling intervals.
- Descriptions of intact unconsolidated soil samples will include parameters listed in Table 1. Material will be described in the following order:
 - Material type (i.e., sand [sandstone], silt [siltstone], clay [claystone], etc.)
 - Color
 - Grain size, sorting, rounding, and make-up of the material (for sand or gravel)
 - Types and amounts of secondary constituents
 - Other pertinent characteristics (plasticity, hardness, bedding, etc.)
 - Moisture content
 - USCS code (for unconsolidated material)
- Unconsolidated materials will be classified in accordance with the USCS (equivalent to ASTM D 2488-93, "Description and Identification of Soil [Visual Manual Procedure]"; Attachment I and USEPA Manual 625/12-91/002 "Description and Sampling of Contaminated Soils"). Soil classifications will be made in the field at the time of sampling by the site geologist and are subject to change based on laboratory tests and subsequent review.

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Borehole Logging

- In the field, visual estimates of the volume of secondary soil constituents will be reported by such terms as "trace" (1-3 percent), "slightly" (3-10 percent), "some" (10-25 percent), and "very" (25-50 percent) or by an estimated percentage.
- Consolidated material (e.g., igneous and metamorphic rocks) will be described by parameters listed in Table 2 and described in Tennisen (1983), ASTM D5434-97, "Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock", and ASTM C294-86(1991), "Standard Descriptive Nomenclature for Constituents of Natural Mineral Aggregates". Material will be logged using drill cuttings and/or rock core. Material will be described in the following order:
 - Rock Type
 - Color
 - Grain size and shape
 - Texture (stratification, foliation)
 - Mineral composition
 - Weathering and alteration
 - Strength
 - Other relevant notes
- For rock core, a scaled graphic sketch of the core breaks denoting the depth, location, and orientation will be drawn on the log. Bedrock coring information will be recorded in consecutively numbered runs and will include the start and stop time of each core run, the depth to top and bottom of each core run, the length of core recovered for each run, the size and type of coring bit and barrel, and the measured depth to the bottom of the hole after the core is removed from each run. Breaks believed to be machine induced, or purposely made so that the core could fit in the core box, will be so annotated. If fractures are too numerous to be shown graphically, they may be described in writing on the log. The intervals by depth of all lost core and hydrologically significant details will also be noted. This information will be recorded at the time of core logging.
- Drill cuttings will be described in terms of the appropriate parameters, to the extent practical. "Classification" will be minimally described for this material, along with a description of drilling actions and water losses/gains for the corresponding depth. Notations will be made on the log that these descriptions are based on observations of material other than formal samples (e.g., from cuttings).
- The drilling equipment used will be described on each log. Information such as drill rod size, bit size and type, and rig manufacturer and model will be recorded.
- All special problems encountered during drilling and their resolution will be recorded on the log. This would include loss of circulation, sudden tool drops, unrecovered tools in the borehole, and lost casing.

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- The dates for the start and completion of borings will be recorded on the log. Changes in shift, day, driller, and site geologist will also be noted at the depth they occur.
- Stratigraphic/lithologic changes will be identified on the boring log by a solid horizontal line at the appropriate scale depth on the log which corresponds to measured borehole depths at which changes occur, measured and recorded to the nearest 0.5 foot. Gradational transitions and changes identified from cuttings or methods other than direct observation and measurement will be identified by a horizontal dashed line at the appropriate scale depth based on the best judgment of the logger.
- Logs will show borehole and sample diameters and depths at which drilling or sampling methods or equipment change.
- Logs will show total depth of penetration and sampling. The bottom of the hole will be so identified on the log by solid double lines from margin to margin with the notation "bottom of borehole."
- Logs will identify the depth at which water is first encountered, the depth of water at the completion of drilling, and the stabilized depth to water. The absence of water in borings will also be indicated. Stabilized water-level data will include time allowed for levels to stabilize.
- Logs will identify any drilling fluid (water) losses, including depths at which they occur, rate of loss and total volume lost.
- Blow counts will be recorded in half-foot increments when a standard penetration test is performed. For penetration less than a half-foot, the count will be annotated with the distance over which the count was taken. Refusal, if reached, will be noted.
- Logs will include other information relevant to a particular investigation, but not limited to:
 - ⇒ Odors
 - ⇒ Field screening or test results (e.g., organic vapors and/or radiological)
 - ⇒ Any observed evidence of contamination in samples, cuttings or drilling fluid
- Significant color changes in the drilling fluid return will be recorded, even when intact soil samples or rock core are being obtained. The color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change will be recorded.
- Special abbreviations used on a log will be defined either in the log where used, or in a general legend.

6.0 DOCUMENTATION

Project staff are responsible for documenting sampling activities. A field boring log form (Appendix C of the QAPP) will be completed summarizing field activities. Field notes will also be kept during drilling and logging activities. The following information will be recorded in a bound field log book:

- Names of personnel
- Weather conditions

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Borehole Logging

- Date and time of drilling and sampling
- Location and sample station number
- Times that procedures and measurements are completed
- Decontamination times
- Calibration information
- Boring log information
- Other applicable information

7.0 REFERENCES

ASTM D2488-93 Standard Practice for Description and Identification of Soils (Visual Manual Procedure)

ASTM D5434-97 Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock

ASTM C294-86(1991) Standard Descriptive Nomenclature for Constituents of Natural Mineral Aggregates

USEPA Manual 625/12-91/002 Description and Sampling of Contaminated Soils,

Tennisen, A.C., 1983, Nature of Earth Materials, 2nd Edition, pp.204-348.

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Borehole Logging

TABLE 1
DESCRIPTION OF UNCONSOLIDATED SOIL

Parameter	Example
Depositional Environment and Formation, (if named and if known)	Alluvium, Twin Cities Formation
Unified Soil Classification System	Sandy Clay
Secondary Components and Estimated Quantities either by percentages or by descriptive percentage ranges (Note: terms used to indicate ranges should be described on the log or in a general legend)	sand: fine, with trace of med.
Color	gray
Consistency (cohesive soil). Use relative term	very soft, soft, medium, stiff, very stiff, hard
Density (non-cohesive soil). Use relative term	loose, medium, dense, very dense
Moisture Content. (Use relative term. Do not express as a percentage unless a value has been measured)	dry, damp, moist, wet, saturated
Texture/Fabric/Bedding	no apparent bedding, numerous vertical iron-stained tight fractures
Grain Angularity	rounded sand grains
Sorting (sands)	poorly sorted
Structure	slickensides
Grain or fragment size	coarse
Note "Fill", "Top of Natural Ground", and "Top of Bedrock" where appropriate	

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Borehole Logging

TABLE 2
DESCRIPTION OF CONSOLIDATED ROCK

Parameter	Example
Formation Name (if known)	Togo Formation of the Belt Supergroup
Rock Type	Quartz monzonite, granite
Modifier denoting variety	Shaley, calcareous, siliceous, argillaceous, sandy, micaceous
Grain Size	Very coarse-grained, coarse-grained, medium-grained, fine-grained, very fine-grained
Grain Shape	Angular, subangular, subrounded, rounded, well-rounded
Color	Medium brown
Stratification/Foliation	Parting band, thinly bedded, thickly bedded, very thickly bedded, laminated, (Note: provide thickness range of each in legend)
Texture	Crystalline, porphyritic, glassy, poorly cemented, well cemented
Weathering/Alteration	Residual soil, completely weathered/altered, highly weathered/altered, moderately weathered/altered, slightly weathered/altered, fresh
Rock Strength	Extremely weak, very weak, weak, medium strong, strong, very strong, extremely strong
Structure and Orientation	Horizontal bedding, dipping beds at 30°, highly fractured, open near vertical joints, healed 30 degree fractures, slickensides at 45 degree, fissile
Core loss interval and reason for loss if known or "Unaccountable"	50-51', noncemented sandstone likely

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Borehole Logging

Attachment I

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) ASTM D2488-93

SOP NUMBER 3

Monitoring Well Installation

SOP NUMBER 3

Monitoring Well Installation

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Monitoring Well Installation

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the Standard Operating Procedure (SOP) for installing groundwater monitoring wells in unconsolidated geologic materials and bedrock at the Midnite Mine Site and in surrounding areas. It describes designs, procedures, and materials used to construct monitoring wells that will produce accurate groundwater level measurements and representative groundwater samples. The well locations are specified in Section 2.0 of the Sampling and Analysis Plan (Appendix A of the Quality Assurance Project Plan {QAPP}). The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly install monitoring wells.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Site Manager and/or Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with the following SOPs:

- SOP No. 4 Monitoring Well Development
- SOP No. 5 Monitoring Well Water-Level Measurement
- SOP No. 6 Groundwater Sampling
- SOP No. 10 Decontamination

4.0 EQUIPMENT REQUIRED FOR GROUNDWATER MONITORING WELL INSTALLATION

Equipment that will be used for installing groundwater monitoring wells includes (American Society for Testing and Materials [ASTM] 1996, U.S. Environmental Protection Agency [EPA] 1986, 1990).

- Well casing and well screen
- Bentonite pellets for the annular seal

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- Filter pack sand
- Cement and powdered bentonite for grouting
- Stainless-steel centralizers
- Protective steel well casing with locking cap
- Steel guard posts
- Decontamination equipment and supplies (See SOP No. 10 Decontamination)
- Well location map
- Drill rig capable of installing wells to the desired depth in the expected formation materials and conditions (i.e., capable of hanging well casing, tremie pumping sand and grout, and accurate measurement of material in the annulus). (See SOP No. 1 Drilling and Sampling of Subsurface Materials.)
- Weighted tape measure
- Water level probe
- Disposable latex gloves
- Appropriate health and safety equipment
- Waterproof pens
- Field logbook
- Calculator
- Well construction log sheets (an example is included in Appendix C of the QAPP).

5.0 GROUNDWATER MONITORING WELL INSTALLATION PROCEDURES

Well construction procedures will fulfill all applicable regulatory agency requirements for permit applications, material standards, and construction/completion protocols. Licensing and/or certification of the driller may be required. In order to maintain quality control and obtain accurate information, a field geologist or hydrogeologist will be on the site to supervise well construction and log details of the procedure. All activities will be conducted in conformance with the Project Health and Safety Plan.

5.1 MAINTENANCE OF DRILL RIG EQUIPMENT AND WELL MATERIALS

- Decontamination procedures specified in SOP No. 10 Decontamination, will be performed.
- Injection and water pumps will be cleaned.

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- Any leaks from the drill rig occurring during well installation will be fixed or contained in such a way that they will not contaminate the borehole.
- Care will be taken not to contaminate the well casing or the borehole with diesel fluid, hydraulic fluid, WD-40, oil, dirty tools, and so forth.
- Drillers will use clean gloves when handling downhole equipment. Different gloves will be used for performing activities such as fueling, adding oil, and working on equipment.
- Pipe lubricants that are used should not introduce contaminants into the borehole. Lubricants that are environmentally acceptable include Green Stuff®, King Stuff®, vegetable oil, Crisco™, and some Teflon™-based lubricants. Lubricants that are not acceptable include petroleum-based and most metal-based lubricants. The Site Manager will pre-approve lubricants that will be used, and the Material Safety Data Sheets (MSDS) for these lubricants will be provided for reference.
- All well casing and screen will be free of foreign material. Casing and screen will be stored off the ground in the original manufacturer's shipping containers until they are installed in the borehole. Before installation, well casing, screen, and centralizers will be certified clean from the manufacturer or will be decontaminated according to SOP No. 10 Decontamination. Acid rinse solutions should not be used for PVC decontamination. Clean latex or nitrile gloves will be worn when handling the well materials.

5.2 MONITORING WELL DESIGN AND COMPLETION

Procedures for installing three types of monitoring wells are presented in this section: water table wells in unconsolidated materials; water table wells in bedrock; and, deep bedrock wells below the water table. Installation of water table wells in unconsolidated material and bedrock is discussed in Section 5.2.2. Monitoring well installation in deeper bedrock borings is described in Section 5.2.3.

5.2.1 GENERAL WELL INSTALLATION PROCEDURES

Monitoring wells will be constructed in open boreholes or through the hollow stem augers or surface casing, depending on the stability of the borehole and materials encountered during drilling (ASTM 1996, EPA 1990).

For boreholes that may need to be backfilled to a certain depth before well installation, bentonite pellets will be added to fill the borehole to the desired depth for well installation. Wax coated pellets may be used if the saturated water column in the borehole is greater than 50 feet.

The annular space will be filled with a filter pack (adjacent to the well screen), a bentonite seal, and casing grout between the well string and the borehole wall. As the annular space is being filled, the well string will be centered and suspended such that it does not rest on the bottom of the hole. At least two stainless steel centralizers will be used if the well is deeper than 50 feet—one at the bottom of the well

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screen and one at the top of the well screen. For deep bedrock wells, additional centralizers will be attached to the riser casing at 100 foot intervals and one near the top of the well string.

The field geologist will calculate and record the volume of the filter pack, bentonite seal, and grout required to fill the annular space based on the borehole size and casing size. The volume is calculated by subtracting the volume of the casing (based on the outer diameter) from the volume of the borehole using the equation:

$$V = (r_b^2 - r_c^2)h$$

where:

V = volume (in feet³)

r_b = radius of borehole (in feet)

r_c = radius of casing (in feet)

h = height (in feet) between the top and bottom of the material (filter pack, bentonite, or grout).

Measurements made during filling of the annular space will be performed to the nearest 0.1 foot below ground surface (bgs) and will consist of the following:

- Total depth of borehole at the completion of drilling
- Total depth of the open borehole before the start of well construction
- Lengths of the end cap, screen sections, riser blank sections, and stickup of well above ground surface
- The depth to the top of the filter pack, top of the bentonite seal, and the top of each grout lift.

Following well completion, the horizontal location of the monitor well will be surveyed in accordance with SOP No. 14 GPS Surveying. The elevation of the ground surface and top of the PVC casing (i.e., water level measuring point) will also be determined. A notch will be cut on the north side of the PVC casing that will be used as a measuring point for water levels.

5.2.1.1 Casing and Screen Requirements

The casing requirements will be as follows (EPA 1990):

- All casing will be new, unused, and decontaminated according to the specifications of Section 5.1.
- All PVC will conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System).
- The casing will be straight and plumb.

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Well screen requirements include:

- All requirements for casing, except for strength requirements, apply to well screens.
- Well screens will be 15 feet to 20 feet in length.
- Screens shall be machine-slotted.
- Screen slot openings shall be 0.010 inches or 0.040 inches depending on subsurface material sizes and groundwater flow rates.
- The bottom of the screen will be capped with a threaded cap.
- The top of the well screen will be placed above the static water level, if possible (except for the deep bedrock wells).

5.2.1.2 Well Filter Pack

The purpose of the well filter pack is to provide lateral support for the well screen, increase yield by improving the hydraulic conductivity in the immediate vicinity of the well, and retain the formation to prevent natural materials from entering the well. The filter pack material will be clean, inert, and well rounded, and will contain less than 2 percent flat particles. The filter pack material will be certified free of contaminants by the vendor or contractor. The filter pack will consist of 10/20 or 20/40 mix or equivalent of clean silica sand and will be placed from the bottom of the hole to at least 2 feet, but not more than 4 feet, above the top of the well screen (5 to 7 feet in the bedrock water table wells). The size of the filter pack material used will be selected as appropriate for the well screen slot size installed so that no more than 10% of the filter pack material is smaller than the slot size (ASTM 1996, EPA 1990). For auger boreholes, the filter pack will be placed in the hole by pouring the sand through the augers and slowly raising the augers out of the hole. For bedrock monitoring wells installed in open boreholes (by air rotary drilling), the screen and riser casing will be suspended at least one foot above the bottom of the borehole as the filter pack is poured directly into the borehole. The volume of the filter pack placed in the well will be recorded.

After the filter pack is placed, the well will be surged with a surge block or bailer for 10 minutes to ensure that the filter pack is settled so that the grout in the annular seal does not come into contact with the well screen. The top of the sand pack will be sounded using a weighted tape to verify its depth during placement. Additional filter pack material will be placed as required to return the level of the pack to at least 2 feet above the screen and the well will be surged for an additional 5 minutes. Again, additional filter pack material will be placed, as required, to bring the level to at least 2 feet above the screen.

5.2.1.3 Well Seal

The materials used to seal the annulus between the borehole wall and casing must prevent potential contaminant migration from ground surface or intermediate zones, isolate a discrete monitor zone,

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preserve confining conditions, prevent intrusion of the overlying grout into the filter pack, and must prevent cross-contamination between strata. The bentonite seal will consist of at least 3 feet, but not more than 5 feet, of bentonite pellets between the filter pack and the casing grout. A minimum of 20 feet of bentonite seal will be used in the bedrock water table wells. Wax-coated sodium bentonite pellets (delayed hydration) may be used to allow the bentonite to fall through the water column and prevent bridging if the saturated water column is greater than 50 feet. If the bentonite seal is placed above the water table, then the bentonite will be hydrated using deionized or distilled water.

5.2.1.4 Annulus Backfill/Grout

The annular space above the filter pack and seal will be grouted with a bentonite/cement mixture. Grouting is used to minimize the vertical migration of water to the screened interval and to increase the stability and integrity of the well casing.

The cement/bentonite grout mixture shall consist of 95 to 97 percent Type V or Type II-V Portland Cement and 3 to 5 percent bentonite powder by weight (equivalent to one 94-pound bag of cement and between 2.8 and 4.7 pounds of bentonite). Approximately 8.5 gallons of water shall be used for each cement/bentonite batch. The grout mixture shall be prepared by thoroughly mixing the bentonite powder with water first and then mixing in the cement (USEPA 1990).

The casing grout requirements are as follows:

- The bentonite seal will be allowed to hydrate for a minimum of one hour before the grout is placed.
- The annular grout will extend from the top of the bentonite seal to approximately 3 feet below ground surface (bgs).
- Grout shall be placed in the well annulus using a side-discharge tremie pipe located within approximately 10 feet of the top of the bentonite seal and the tremie pipe will be pulled up as the annular space is filled. The tremie pipe will have a minimum inner diameter of 1.25 inches and be composed of steel or PVC.
- No single lift of grout will exceed 100 feet and each lift will be allowed to set before the next lift is placed.
- Pumping will continue until undiluted grout has been returned to the surface.
- After grouting, the well shall not be disturbed or be developed for a minimum of 24 hours. Additional grout will be added if settling occurs.

Alternatively, the annular space can be backfilled with a bentonite slurry if the potential exists for cross-contamination of adjacent wells. This may occur when wells are installed in pairs, and the grouted interval in a deep well coincides with the water bearing zone to be screened in a shallow well.

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5.2.1.5 Surface Seal Installation

Groundwater monitoring wells will be constructed with above-ground completions. A concrete surface seal will be placed around the annulus of the well to a minimum depth of one foot or to the top of the bentonite/cement grout, whichever is deeper. Twenty-four hours should elapse between grout emplacement and installation of the surface seal to allow the grout to cure and shrink and prevent a cavity from forming between the two seals. The well casing will be extended 2 to 3 feet above land surface, and a reference point will be marked for future water level measurements on the north side of the casing using a decontaminated metal file. A casing cap for each well will be provided, and the extended casing will be shielded with a protective steel casing that has a locking cap placed over the PVC well casing. The steel casings will be cemented in place and will extend a minimum of 3 feet below ground surface and 3 feet above ground surface. Center the protective steel casing around the monitor well casing and insert the steel casing approximately 3 feet into the cemented annulus. The protective casings will be a minimum of 6 inches larger in diameter than the PVC monitoring wells. The protective steel casing will be seated in a 4-foot by 4-foot by 6-inch concrete surface pad. The pad will be sloped away from the protective casing. The concrete pad surface will extend approximately 1 inch above ground surface with about 5 inches below grade. At least one small hole will be drilled at the base of the protective casing to allow water to drain from the casing. The well number or identification code will be indelibly marked on the protective casing and on the well cap. A lockable cap or lid will be installed on the protective casing. In high traffic areas near roads or parking areas, the steel protective casing will be protected by four, 4-inch-diameter, Schedule 40, steel guard posts. The guard posts will be 6 feet in total length, with 3 feet bgs and 3 feet above ground surface. The guard posts will be set in concrete, but will not be installed in the concrete pad placed at the well base (ASTM 1996, EPA 1990).

All wells will be secured as soon as possible after drilling. Corrosion-resistant locks will be provided for the steel protective casing. The locks must either have identical keys or be keyed for opening with one master key.

5.2.2 Water Table Monitoring Wells

Water table wells will be installed in both unconsolidated materials and bedrock (consolidated) material. These two types of monitoring wells may require slightly different installations as discussed in the following subsections.

5.2.2.1 Unconsolidated Water Table Monitoring Well Materials

These monitoring wells will be installed in boreholes created by hollow-stem auger (HSA) drilling (SOP No. 1 Drilling and Sampling of Subsurface Materials). The well installation will be accomplished by placing the screen and riser pipe through the inside of the augers. The filter pack will be added and the augers will be sequentially removed from the borehole, while carefully sounding the top of the filter pack to maintain the proper thickness of sand and to ensure that the filter sand does not bridge.

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These shallow wells will be constructed of 4-inch diameter, Schedule 40 PVC. Well casing and screen will be flush threaded and the screen interval will be 15 to 20 feet in length. As discussed in Section 5.2.1.1, well screens will straddle the water table to allow for seasonal fluctuations (i.e., approximately 5 feet of the screen will be above the water table and 10 feet will be below the water table).

5.2.2.2 Bedrock Water Table Monitoring Well Materials

These monitoring wells will be installed in boreholes created by an air rotary/casing advance system (SOP No. 1 Drilling and Sampling of Subsurface Materials). The well installation is accomplished by placing the screen and riser pipe into the open borehole after the drilling equipment has been removed.

If the borehole/monitoring well will be located in a significant thickness of alluvial material, mining spoils, or weathered bedrock, a surface casing will be installed to the depth of competent bedrock.

All screen and casing requirements described for unconsolidated water table monitoring wells apply for bedrock water table wells, except that Schedule 80 PVC casing and screen will be installed. The screens will straddle the water table as previously discussed.

5.2.3 Deep Bedrock Monitoring Wells

Deep bedrock monitoring wells will be installed in consolidated bedrock material 100 to 200 feet below the water table.

5.2.3.1 Deep Bedrock Monitoring Well Materials

Deep bedrock monitoring wells will be installed in boreholes created by air rotary/casing advance technology. The screen and well casing will be suspended off the bottom of the borehole in order to protect the screen. Materials used for these deep wells will be the same specifications as described above with the exception of the use of Schedule 80 PVC. Screens will be 20 feet in length.

The filter pack will meet the same specifications as described in Section 5.2.1.2. The filter pack will be installed to a minimum of 7 feet above the top of the screen in order to protect the well screen.

Bentonite seal specifications are as described in Section 5.2.1.3. The seal in the deep wells will be a minimum of 20 feet thick to protect the well screen from grout infiltration.

6.0 DOCUMENTATION

6.1 Monitoring Well Completion Diagrams

A completion diagram will be prepared for each groundwater monitoring well when installed (Appendix C of the QAPP, Monitoring Well Installation Log). It will include the following information:

- Well identification (identical to the borehole identification)

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- Drilling method
- Installation date(s)
- Total boring depth and total well depth
- Lengths and descriptions of the screen and casing
- Depths and descriptions of the filter pack, bentonite seal and casing grout
- Elevation of water surface before and immediately after well installation
- Summary of the material penetrated by the boring

6.2 Field Logbook

Observations and data acquired in the field during installation of monitoring wells will be recorded to provide a permanent record (EPA 1986). These observations will be recorded with waterproof black ink in a bound, weatherproof field logbook with consecutively numbered pages. Corrections will consist of line-out deletions that are initialed and dated. If, during cold weather, the ink pen fails, a pencil may be used to record observations. The information in the field logbook will include the following, as appropriate:

- Project name and number
- Names and titles of all field personnel
- Drilling company name and personnel
- Type of drill rig
- Date well installation started and finished
- Boring number
- Well installation observations
- Daily progress
- Problems encountered and resolution
- Decontamination observations
- Weather conditions
- Grout, sand, and bentonite volume calculations prior to well installation
- The volume and composition of the grout, seals, and filter pack actually used during construction
- All measurements made to top of filter pack, seal, grout batches, screened interval, and other depths

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- Screen slot size (in inches), slot configuration, nominal casing size, schedule, composition, and manufacturer
- Centralizer composition and locations
- Protective casing composition and nominal ID
- Surface completion information and date
- General groundwater observations
- Overnight water levels (before installation begins)
- Protective casing and surface completion details
- Other pertinent information

The field logbooks will be used daily by the field personnel and will be kept in the possession of field personnel or in a secure location during the project. All documentation regarding monitoring well installation will constitute a portion of the permanent project record.

7.0 REFERENCES

U.S. EPA. 1986. "RCRA Groundwater Monitoring Technical Enforcement Guidance Document (T.E.G.D.)." U.S. Environmental Protection Agency, Washington D.C., Document No. OSWER-9950.1

U.S. EPA. 1990. "Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells". U.S. Environmental Protection Agency, Washington D.C., Document No. EPA/600/4-89/034.

American Society for Testing and Materials (ASTM). 1996. "ASTM Standards on Groundwater and Vadose Zone Investigations: Drilling, Sampling, Well Installation and Abandonment Procedures."

SOP NUMBER 4

Monitoring Well Development

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Monitoring Well Development

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SOP NUMBER 4

Monitoring Well Development

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods for developing groundwater monitoring wells installed as part of the Remedial Investigation/Feasibility Study (RI/FS) at Midnite Mine, Spokane Indian Reservation, Washington. This SOP explains the necessary equipment and procedures for well development in both bedrock and alluvial wells.

The purpose of well development is to restore the hydraulic conductivity of the aquifer material surrounding the well to near pre-well installation conditions. This is accomplished by removing well drilling fluids, solids, or other particulates that may have been introduced or deposited on the borehole wall during drilling and well construction activities. Properly developed monitoring wells allow for the collection of representative groundwater samples.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with the following SOPs:

- SOP No. 3 Monitoring Well Installation
- SOP No. 5 Monitoring Well Water-Level Measurement
- SOP No. 7 Field Parameter Measurements
- SOP No. 10 Decontamination

4.0 EQUIPMENT NECESSARY FOR MONITORING WELL DEVELOPMENT

The following items will be required to develop groundwater monitoring wells:

- Well completion logs
- Well development forms (see Appendix C of the QAPP)

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Monitoring Well Development

- Well keys
- Stainless steel, adjustable rate, submersible pump, controller, and power source (generator or battery)
- Surge block
- Teflon® or Teflon-lined polyethylene tubing
- Stainless steel or Teflon® bailer
- Mechanical reel or truck-mounted wireline rig (for deep wells)
- Water quality meters for temperature, conductivity, pH and turbidity
- Plastic sheeting
- Decontamination equipment and supplies (see SOP No. 10 Decontamination)
- Personal protective equipment (PPE) as outlined in the Health and Safety Plan (HSP)
- Organic vapor detector (on wells scheduled for volatile organics analysis)
- Graduated 5-gallon bucket
- Drums or other large container for storing development water
- Water-level probe
- Weighted tape measure
- Calculator

5.0 MONITORING WELL DEVELOPMENT PROCEDURES

Before developing any well where samples will be collected for volatile organic compound (VOC) analysis, the head space in the well must be measured using an organic vapor detector as described in the Health and Safety Plan (HSP). The initial static water level will also be measured before development begins and well purge volume requirements will be calculated.

Monitoring well development will be accomplished using a surge block and/or a bailer and a submersible pump to flush the screen, sand pack material, and borehole wall of drilling fluids and fine sediment resulting from well drilling and installation activities. This procedure also allows for the removal of fine sediment, which may have accumulated within the inner well casing.

The surge block will initially be operated with short, gentle strokes above the well screen intake. Development will begin at the static water level and move progressively downward to prevent the surge block from becoming sand locked. The surge energy shall be gradually increased at each depth.

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Surging shall be alternated with removal of the fines with a pump or bailer. Note that surging of low-permeability formations can result in a collapsed well screen. Development of fine-grained materials will be accomplished by a gentle action to avoid reducing the natural hydraulic conductivity.

Well development will begin no sooner than 24 hours after the well as been grouted and will consist of removing approximately 3 to 10 well casing volumes from the well, plus a volume of water equal to any additional potable water added to the borehole during drilling or well installation. A well casing volume is determined by the following formula for 4-inch diameter wells:

$$(1) \text{ Well casing volume (gal)} = \text{Depth to bottom of well (ft)} - \text{Depth to water level (ft)} \times 0.65 \text{ (gal/ft)}$$

(For a 2-inch diameter well, replace 0.65 with 0.16; and for a 6-inch diameter well, replace 0.65 with 1.5)

All depth measurements are taken from the top of the well casing at the designated measuring point. A weighted tape measure and electronic water-level indicator will be used to determine the depth to bottom of well and depth to water level. These procedures are discussed in SOP No. 5 Monitoring Well Water-Level Measurement.

Field parameters including pH, temperature, conductivity, and turbidity will be measured after each well casing volume has been evacuated. The calibration and operation of pH, conductivity and turbidity meters is discussed in SOP No. 7 Field Parameter Measurements. The well will be developed until these field parameters have stabilized. Stabilized field parameters are defined as three consecutive readings where temperatures are within 1°C, pH readings are within 0.2 units, and conductivity and turbidity values are within 10%. If for any reason this cannot be accomplished, the well will be considered developed after being purged of 10 well casing volumes.

For slow producing wells (wells that do not fully recover within 8 hours), the wells shall be purged dry a minimum of three times. All purge water from the wells will be placed into an appropriate container and handled as IDW as discussed in the SAP.

All development equipment coming in contact with well water will be decontaminated in accordance with SOP No. 10 Decontamination, before each well is developed. Development equipment will be protected from the ground surface with clear plastic sheeting.

6.0 DOCUMENTATION

The following well development information will be recorded on the Well Development Form found in Appendix C of the QAPP and in the field logbook.

- Well I.D. and location
- Date of well installation
- Date and time of well development

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Monitoring Well Development

- Static water level from top of casing before and after development
- Total depth of well from top of casing
- Quantity of water used during drilling
- Volume of well casing volume
- Field measurements of pH, conductivity, turbidity, and temperature taken after each well casing volume has been evacuated
- Physical description of removed water throughout development
- Types of bailers/pumps etc. used to evacuate water
- Quantity of water removed and time of removal (incremental and total values)

SOP NUMBER 5

Monitoring Well Water-Level Measurement

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Monitoring Well Water-Level Measurement

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SOP NUMBER 5

Monitoring Well Water-Level Measurement

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the Standard Operating Procedure (SOP) for measuring water levels in groundwater monitoring wells at the Midnite Mine (Site).

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with the following SOPs:

- SOP No. 3 Monitoring Well Installation
- SOP No. 4 Monitoring Well Development
- SOP No. 6 Groundwater Sampling
- SOP No. 10 Decontamination

4.0 EQUIPMENT NECESSARY FOR MEASURING WATER LEVELS

The equipment and supplies that may be necessary to measure water levels include:

- Electronic water-level probe
- Decontamination supplies (see SOP No. 10 Decontamination)
- Field logbook or field data sheets
- Tape measure (marked in increments of 0.1 and 0.01 feet).

5.0 WATER-LEVEL MEASUREMENT PROCEDURES

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Monitoring Well Water-Level Measurement

This section provides the procedure to follow when measuring water levels in groundwater monitoring wells. Refer to the water-level probe manufacturer's instructions for specific instrument operating procedures.

- Before mobilization, obtain previous water level data, a description of the measuring point for water-level measurements for all wells, and the appropriate well keys (if the wells are locked).
- Test the water-level probe to verify that it is working properly by pushing the circuit test button or as specified in the instrument manufacturer's instructions.
- Decontaminate the water-level indicator probe according to the decontamination procedure described in SOP No. 10 Decontamination, before the first measurement, between wells, and after measuring the water level in the last well.
- Unlock and open the well. Follow the health and safety procedures specified in the project health and safety plan (HSP) and, if necessary, let the well vent any gases that may be present in the well casing.
- After opening the well cover, locate the water-level measuring point on top of the inner well casing (not the protective steel casing). If a measuring point is not marked, the measurement should be taken from the north side of the PVC casing, if possible.
- Measure the static water-level by lowering the water-level probe into the well until the buzzer/light indicates that the probe tip has contacted water. Alternately raise and lower the water level probe to determine the exact depth at which the water level indicator is activated.
- Record the water-level depth to the nearest 0.01 foot in the field logbook or on a field data sheet. In addition, document the measuring point location. Compare the most recent measurement with past measurements and verify that the new measurement is reasonable before leaving the well. If the measurement does not seem reasonable, measure the water level again.
- If the water-level indicator fails to activate and is operating properly, lower the water level probe to the bottom of the well to ensure that the well is dry. Document that the well is dry and record the total measured well depth in the field logbook or on the appropriate field form. If measuring total depth with an electronic probe, be certain to account for the length of the probe tip that is commonly in addition to the graduated tape that is referenced to the electronic probe.

6.0 DOCUMENTATION

Water-level measurements will be recorded in the field logbook and on the water level measurement form (Appendix C of the QAPP). Entries in the logbook shall be legible, signed or initialed, and dated. Documented information shall include, as appropriate:

- Personnel who performed the measurement

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Monitoring Well Water-Level Measurement

- Date of measurement
- Time of measurement
- Well number
- Depth to water from the measurement point
- Description of the measurement point location for the well (if different from previous measurement point)
- Water-level probe manufacturer and serial/identification number
- Calculations performed (if any)
- Other observations (i.e., well condition, evidence of tampering, artesian conditions)

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Groundwater Sampling

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Groundwater Sampling

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SOP NUMBER 6

Groundwater Sampling

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to conduct groundwater sampling during the Remedial Investigation/Feasibility Study (RI/FS) at the Midnite Mine Site, Spokane Indian Reservation, Washington.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedure are followed by all personnel.

All personnel performing these procedures are required to have appropriate health and safety training. In addition, all personnel are required to have complete understanding of the procedures described within this SOP and receive specified training regarding these procedures, if necessary.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with the following SOPs:

SOP No. 3	Monitoring Well Installation
SOP No. 5	Monitoring Well Water-Level Measurement
SOP No. 7	Field Parameter Measurements
SOP No. 10	Decontamination
SOP No. 11	Sample Handling, Shipping, and Documentation

4.0 EQUIPMENT NECESSARY FOR GROUNDWATER SAMPLING

The following items may be required to properly sample groundwater monitoring wells:

- Well completion logs
- Groundwater sampling forms (see Appendix C of the Quality Assurance Project Plan [QAPP])
- Well keys
- Sample collection supplies (e.g., appropriate laboratory-supplied sample containers, sample labels, cooler for sample storage, ice, etc.)
- Sample filtering supplies (e.g., hand or peristaltic pump, Tygon or silicon tubing, disposable 0.45-micron filters)

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Groundwater Sampling

- Stainless steel, adjustable rate, submersible pump, controller, and power source (generator or battery)
- Teflon or Teflon-lined polyethylene tubing
- Water quality meters for temperature, conductivity, pH and turbidity
- Plastic sheeting
- Decontamination equipment and supplies (see SOP No. 10 Decontamination)
- Personal protective equipment (PPE) as outlined in the Project Health and Safety Plan (HSP)
- Organic vapor detector (on wells scheduled for volatile organics analysis)
- Graduated cylinder and bucket for measuring flow rate and volumes
- Drums or other large container for capturing and storing purge water
- Water-level probe
- Weighted tape measure

5.0 GROUNDWATER SAMPLING PROCEDURES

This section gives procedures for well purging and collecting water samples using a submersible pump. Observations made during sample collection will be recorded in the field notebook and groundwater sample field data sheet. Groundwater samples will be collected for the laboratory chemical analyses described in the QAPP. The type and frequency of QA/QC samples is also specified in the QAPP.

All non-dedicated purging and sampling equipment coming in contact with well water will be decontaminated in accordance with SOP No. 10 Decontamination, before each well is sampled. If dedicated equipment is used, it should be rinsed with distilled or de-ionized water. Sampling equipment will be protected from the ground surface with clear plastic sheeting.

Before sampling any well for volatile organic compound (VOC) analysis, the headspace in the well will be measured using an organic vapor detector as described in the HSP.

Electronic equipment used during sampling includes pH, conductivity, and turbidity meters, and an electronic water-level indicator. Before going into the field, the sampler shall verify that all of these are operating properly and are properly calibrated before each day's use. Operation and calibration of field meters is discussed in SOP No. 7 Field Parameter Measurements.

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Groundwater Sampling

5.1 PURGING

The purpose of well, or borehole, purging is to remove stagnant water from the well and obtain representative water from the geologic formation being sampled. Wells will be purged using the following low stress (low flow) purging procedure:

- Before starting purging activities, check well for security damage or evidence of tampering, record pertinent observations.
- Lay out sheet of clean polyethylene for monitoring and sampling equipment.
- Remove well cap and immediately measure VOCs at the rim of the well with a photo-ionization detector (PID) or flame-ionization detector (FID) instrument as described in the HSP.
- Measure the static water level. Measurement of the well depth should be performed 24 hours prior to purging and sampling activities in order to allow disturbed sediments to settle. If not measured the day before, well depth should be measured after sampling of the well is complete.
- Determine the appropriate depth for the submersible pump based on screen interval and measure required length of tubing. Teflon or Teflon-lined tubing should be used for wells where samples for semi-volatile compounds analysis will be performed. Tygon or silicon tubing can be used at other wells. Purging and sampling depth will be at the center of the screened interval in the well, or at the depth of greatest hydraulic conductivity within the screened interval and at least 2 feet above the bottom of the well. The depth of greatest hydraulic conductivity may be determined during drilling, from geophysical logging and well development logs.
- Slowly lower the pump, safety cable, tubing, and electrical lines into the well to the appropriate depth taking care not to disturb settled sediments.
- Before starting the pump, measure and record the water level.
- Start the pump at its lowest speed setting and slowly increase the speed until a steady discharge of 0.5 liters per minute (l/min) is achieved. This flow rate should be confirmed every three to five minutes at the time field parameters are measured.
- Determine water-level drawdown. If drawdown exceeds 0.1 meters (0.3 feet) at the 0.5 l/min flow rate, follow the instructions given in the final bullet of this section. If drawdown remains stable at the 0.5 l/min pumping rate, follow the succeeding steps and continue purging until indicator field parameters stabilize.
- Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate).

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Groundwater Sampling

- During well purging, monitor field parameters pH, conductivity, temperature, and turbidity every three to five minutes. Refer to SOP No. 7 Field Parameter Measurements for operation and calibration procedures.
- Purging is considered complete and sampling may begin when all the above field indicator parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three to five minute intervals, are within the following limits:
 - pH: +/- 0.2 units
 - Conductivity: +/- 10%
 - Temperature: +/- 10%
 - Turbidity: +/- 10% or less than 5 NTUs
- The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.
- If drawdown exceeds 0.1 meters at the 0.5 l/min pumping rate, purge water may not represent recharging formation water; instead, purge water may just represent dewatering of the stagnant borehole water. In this case, reduce the flow rate, but no lower than 0.1 l/min, to try and stabilize the water level. If the water level does not stabilize, purge the well dry either by pumping at a higher flow rate or with a bailer and sample as soon as the water level has recovered sufficiently to collect the required volume.

5.2 SAMPLING

Collect groundwater samples for chemical analyses immediately after or within two hours of purging. For slow recovering wells that are purged dry, the sample shall be collected immediately after sufficient volume is available.

Water samples that are not required to be field filtered can be collected by directly filling pre-preserved sample containers from the pump tubing discharge or teflon bailer. Alternatively, water samples can be collected into clean unpreserved sample containers which are then preserved. The tubing should be free of any air bubbles. VOC sample containers will be filled first. Fill sample containers by allowing the pump or bailer discharge to flow gently down the inside of the container with minimal turbulence. VOC sample containers should be filled completely so that water forms a convex meniscus at the top then capped such that no air space exists in the container. Fill sample bottles for parameters other than volatile organics to almost full and cap quickly.

Samples that require field filtering will be initially collected into clean, unpreserved sample containers. Samples will be filtered with a hand or peristaltic pump and 0.45 µm filter. The filter and filter unit will

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Groundwater Sampling

be rinsed with approximately 25 – 50 ml of sample before collection for chemical analysis. Filtered samples will be immediately preserved.

Measure field parameters specified in the SAP in accordance with procedures described in SOP No. 7, Field Parameter Measurements and record results.

If a flow-through-cell was used to measure field indicator parameters, water samples for laboratory analysis must be collected before water has passed through the cell. This may require disconnecting the flow-through cell before sampling.

Complete and attach sample labels and immediately place all samples in a cooler with ice. After collection of the samples, the pump tubing or bailer may either be dedicated to the well for resampling (by hanging the tubing or bailer inside the well or storing in labeled, clean plastic bags), decontaminated, or properly discarded.

Secure the well when sampling activities are complete.

6.0 DOCUMENTATION

The following groundwater sampling information will be recorded in field logbooks and on the Groundwater Sampling Form found in Appendix C of the QAPP.

- Well ID and location
- Sample ID number
- Depth of well (determined after sampling event)
- Depth to top and bottom of well screen
- Depth of pump intake
- Field personnel
- Purging device (pump type/model number)
- Clock time
- Water depth
- Pump dial setting
- Purge rate
- Cumulative volume purged
- pH, conductivity, temperature, and turbidity
- Any additional comments or observations

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Groundwater Sampling

In addition, the Sample Collection Information log and Monitoring/Sample Location Information log (Appendix C) will be filled in by the samplers.

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Field Parameter Measurements

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Field Parameter Measurements

1.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used to obtain field parameter measurements of surface water or groundwater at the Midnite Mine Site. Field parameters will be measured during monitoring well development, purging and sampling, and during surface water sampling.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

Related SOPs cross-referenced by this SOP are as follows:

- SOP No. 6 Groundwater Sampling
- SOP No. 8 Surface Water Sampling
- SOP No. 10 Decontamination

4.0 EQUIPMENT NECESSARY FOR CONDUCTING FIELD PARAMETER MEASUREMENTS

4.1 GENERAL EQUIPMENT REQUIREMENTS

In addition to the equipment cited in associated SOPs for the collection of surface and groundwater samples (SOP Nos. 6 and No. 8, respectively), the following instruments and supplies, or their equivalent, are necessary for measurement of field parameters.

- Portable pH meter and pH 4, 7, and 10 buffer solutions
- Spare pH probe or electrolyte cartridge, as applicable
- pH electrode storage solution
- Extra batteries for all instruments

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- Conductivity meter and calibration solutions that bracket the expected range of measurements
- FerroVer and Ferrous iron AccuVac ampules (or equivalent)
- Portable dissolved oxygen kit and low and high range dissolved oxygen AccuVac ampuls (or equivalent)
- Portable Eh tester electrode
- Portable turbidity meter
- In-flow multi-measurement meter
- Tygon™ or silicone tubing
- Peristaltic pump
- 12-volt battery
- Beakers of assorted sizes
- Deionized or distilled water
- Wash bottle
- Kimwipes® or equivalent.

5.0 FIELD PARAMETER MEASUREMENT PROCEDURES

Several of the field parameters are physically or chemically unstable and will be tested using either an in-flow multi-measurement system or a field test kit or instrument immediately after sample collection. Examples of unstable parameters include pH, temperature, Eh, ferrous iron, and dissolved oxygen. Although the conductivity of a substance is relatively stable, it is recommended that this characteristic be measured in the field. Most instruments measuring conductivity require temperature compensation; therefore, the temperature of the samples should be measured at the time the conductivity is measured.

Procedures and equipment for use of an in-flow measurement device and instruments for measuring individual parameters are described in this SOP. Certain parameters (e.g., ferrous iron) require measurement by colorimetric methods that cannot be performed using in-flow measurement devices.

Sampling personnel shall wear chemical-resistant gloves, which will be disposed of between locations when performing field measurements

5.1 PROCEDURES FOR COLLECTING A SAMPLE FOR FIELD PARAMETER MEASUREMENTS

Collect water samples as described in SOP Nos. 6 and No. 8. A separate unfiltered grab sample (if not using an in-flow multi-measurement system) will be collected for measuring field parameters. Field parameter measurements should be taken immediately after sample collection. Water in the container

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used for grab sample collection can be used to measure all field parameters. After the measurements have been recorded, the water should be treated as investigation-derived waste (IDW). Do not use this sample for laboratory analysis.

5.1.1 In-Flow Multi-Parameter Monitoring System

The in-flow multi-parameter monitoring system or similar multi-parameter instruments, may be used for measuring pH, temperature, conductivity, Eh, and dissolved oxygen. The Operation and Maintenance Manual shall be followed when operating or calibrating the instrument.

5.2 pH

Determine the pH from a water sample as soon as possible after collecting it, or use an in-flow multi-measurement system. Determine the pH by the electrometric method. The electrometric method is the preferred method because of its greater accuracy and ease of measurement. Either a glass electrode and a reference electrode, or a combination electrode, which combines the glass membrane electrode and the reference electrode, will be used. The procedures described in this section are generic; they were generally written for HACH EC10 and EC20 (or equivalent) pH meters.

5.2.1 pH Meter Calibration Procedure

The pH meter shall automatically compensate for temperature and be capable of calibration with a two-point (using two buffers) slope adjustment method. The meter shall have a precision of at least 0.05 pH units.

Before collecting samples, calibrate the pH meter in accordance with the manufacturer's instructions using standard buffer solutions. The field sampling technician will record all pH measurement data, including calibration dates and times, readings, the meter number, and sample temperatures on either surface water or ground water data sheets or in the field logbook.

Calibrate the pH meter daily prior to field activities. Verify the pH calibration against a pH 7 buffer solution before each sampling location, and recalibrate as necessary per the QAPP. Thoroughly document all calibrations and verification pH readings and temperatures, in the field logbook or data sheets.

The field sampling technician will calibrate the pH meter as follows:

1. Before immersing the probe(s) into the buffer solution or sample, rinse the probe with deionized or distilled water.
2. Calibrate the meter with two buffer solutions (two-point slope adjustment). One of the buffer solutions used for the slope adjustment should approximate the anticipated pH of the sample, and the other buffer should always have a pH of 7. Ensure that the buffer solutions are at the same temperature and are as close as practical to the temperature of the water to be measured.

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3. Record the results of the calibration.
4. Decontaminate pH meter and associated equipment in accordance with SOP No. 10 Decontamination.

5.2.2 pH Measurement Procedure

The field sampling technician will measure pH as follows:

1. If the pH is measured in a container, rinse the sample container with deionized water and then rinse it three times with the sample water prior to measurement. If using an in-flow multi-measurement system, measurements are continuously displayed.
2. Rinse the pH probe with deionized water. Be sure to protect the fragile glass bulb at the end of the probe from damage.
3. Immerse the electrode in the water, allow the pH reading to stabilize, and monitor the drift of the instrument. Do not immerse the electrode above the top of the pH probe.
4. When the pH reading stabilizes (i.e., the meter beeps), record the temperature to the nearest 0.1°C and the pH reading to the nearest 0.01 unit.
5. Between measurements, store the electrode in pH electrode storage solution or equivalent solution, if possible, or put a cotton swab soaked in electrode solution in the protective cap of the electrode.
6. Decontaminate pH meter/ in-flow multi-measurement system and associated equipment in accordance with SOP No. 10 Decontamination.

Note: Avoid prolonged exposure of the pH meter and probe to sunlight.

5.3 CONDUCTIVITY

Electrical conductivity, or specific conductance, is the ability of water to conduct an electric current and depends on the concentration of ions in solution. The relationship between conductivity and the concentration of dissolved solids is approximately linear for most natural waters. Changes in this relationship indicate changes in the proportions of different salts and, therefore, changes in the sources of dissolved substances that enter the water body.

For measuring conductivity in the field, the meter shall have an automatic temperature compensator and shall display conductivity directly in units of microsiemens per centimeter ($\mu\text{S}/\text{cm}$) for samples with a conductivity less than 2,000 $\mu\text{S}/\text{cm}$ or in millisiemens per centimeter (mS/cm) for samples with a conductivity greater than 2.00 mS/cm , corrected to a temperature of 25°C.

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5.3.1 Conductivity Meter Calibration Procedure

Before collecting samples, calibrate the conductivity meter using calibration solutions in accordance with the manufacturer's instructions. The sampler will record all conductivity measurement data, including calibration dates, readings, the meter number, and sample temperatures on a field data sheet or in a field logbook.

Reagent-grade potassium chloride (KCl) or other equivalent solutions are universally used as reference solutions to calibrate conductivity equipment. The reference solutions are also used to check the accuracy of the meter. The conductivity of the reference solutions that are used to calibrate the meter should bracket the expected range of the conductivity of the water samples. Commercially prepared calibration standards are available from laboratory suppliers at many standard concentrations.

The field sampling technician will calibrate the conductivity meter as follows:

1. Calibrate the meter according to the manufacturer's instructions.
2. Prepare or obtain standard reference solutions of a known value at a known temperature. Adjust the meter or the calibration solution to the correct temperature.
3. Adjust the meter to read the reference conductivity.
4. Rinse the probe with deionized water.
5. Re-immerses the probe in the reference solution and read the measured value to validate the corrected conductivity.
6. Record the results of the calibration.
7. Decontaminate conductivity meter/ in-flow multi-measurement system and associated equipment in accordance with SOP No. 10 Decontamination.

Check the calibration of the conductivity meter against a known standard prior to sampling at each location and recalibrate as necessary.

5.3.2 Conductivity Measurement Procedure

Measure conductivity immediately after a field parameter grab sample is collected. Record conductivity readings to the nearest 1 $\mu\text{S}/\text{cm}$ (for samples with conductivities less than 2,000 $\mu\text{S}/\text{cm}$) or 0.01 mS/cm (for samples with conductivities greater than 2.00 mS/cm).

The field sampling technician will measure conductivity as follows:

1. Rinse the probe with deionized water. If using an in-flow multi-measurement system, measurements are continuously displayed.
2. Insert the probe into the parameter sample and agitate the probe vertically.

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3. Allow the reading to stabilize before recording measurements.
4. Record the conductivity and temperature of the sample.
5. During normal use, rinse the probe thoroughly with deionized water between measurements to minimize the buildup of interfering substances on the probe element.
6. Decontaminate conductivity meter/ in-flow multi-measurement system and associated equipment in accordance with SOP No. 10 Decontamination.

Note: Avoid prolonged exposure of the probe to sunlight.

5.4 FERROUS IRON

The ferrous iron concentration will be measured at the time of sample collection using modified HACH Method 8146 or equivalent. AccuVac ampules (or equivalent) containing the appropriate reagents shall be used for visual colorimetric field determination of ferrous iron concentrations in the water samples.

Refer to the instruction manual that accompanies the AccuVac ampules for completion of this test.

Total iron will be measured during metals analysis at an analytical laboratory.

5.5 DISSOLVED OXYGEN

The dissolved oxygen (DO) concentration will be measured with an in-flow multi-measurement system at the time of parameter sample collection or using an in situ probe. DO measurements will be confirmed (at a minimum frequency of 10% of sample locations) using a colorimetric field kit.

The DO meter is factory calibrated; the factory calibration shall be confirmed before the DO meter is sent to the field. Each day before collecting samples and as applicable for the instrument, the in-flow DO probe shall be calibrated to ambient barometric pressure uncorrected for altitude. The in situ DO probe, which may be used for parameter measurements of surface water will be calibrated daily before sample collection in accordance with manufacturer's instructions.

5.5.1 Dissolved Oxygen Measurement Procedure

Inflow DO concentrations are continuously displayed with the multi-measurement system. The field sampling technician will measure DO using the colorimetric field kit according to the manufacturer's instructions. DO measurements made with an in situ probe should also be performed in accordance with manufacturer's instructions. All DO measurements should be recorded along with temperature readings.

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5.6 Eh

The Eh will be measured in the field at selected locations at the time of water sample collection. Either an in situ probe or inflow multi-measurement water will be used for Eh measurement.

The Eh meter shall be calibrated by the contractor prior to being sent to the field. Check the calibration of the Eh meter against a known standard daily, and recalibrate as necessary per the QAPP.

Additionally, an Eh sensitivity verification will be completed each day before collection of samples. Sensitivity verification will be demonstrated by a reduction in Eh with an increase in pH. Consult the manufacturer's instruction manual for proper use.

5.6.1 Eh Measurement Procedure Using a Tester Electrode

The field sampling technician will measure Eh as follows:

1. At the start of each day, measure the Eh and temperature of the standard solution and record results in the field logbook.
2. Remove the Eh electrode cap and turn on the meter
3. Dip the electrode 1/2 to 1 inch into the sample and stir once. The electrode should stabilize within 2 to 5 minutes. When stable, take a reading and record it on the sample data sheet. Any instability will be noted and recorded on the sample data sheet.
4. Decontaminate the Eh meter probe and associated equipment in accordance with SOP No. 10 Decontamination.

5.7 TURBIDITY

The turbidity will be measured at the time of sample collection. A colorimeter (HACH DR700 or equivalent) and ampules (AccuVac) containing the appropriate reagents or a portable turbidity meter will be used for field determination of turbidity in the parameter samples.

The turbidity meter is factory calibrated and requires no field calibration. The factory calibration shall be checked before the turbidity meter is sent to the field. Additionally, the calibration of the turbidity meter will be checked daily before collection of samples against a known formazin standard. The instrument will be recalibrated as necessary based on the daily check per the QAPP. Refer to the manufacturer's instruction manual for proper use.

The turbidity test measures an optical property of the water sample that results from the scattering and absorbing of light by the particulate matter present. The amount of turbidity registered is dependent on such variables as the size, shape, and refractive properties of the particles. This procedure is commonly calibrated using formazin turbidity standards, and the readings are in terms of nephelometric turbidity units (NTUs).

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5.8 TEMPERATURE

Temperature measurements will be made with a high quality mercury-filled thermometer or in-flow multi-measurement system having an analog or digital readout device. This thermometer is to have been standardized by comparison with a thermometer calibrated against a National Institute of Standards and Technology (NIST) calibrated thermometer. All temperature-measuring devices will be scaled to indicate degrees Celsius and marked as appropriate to meet data quality objectives. Glass thermometers will be transported in a protective case to prevent breakage.

5.8.1 Temperature Measurement Procedure

Temperature measurements made for the purpose of providing adjustment factors for other field parameters will be conducted simultaneously with those related measurements. Volumes and methods of collection will be determined by the procedural requirements of the primary field measurement taken.

The field sampling technician will measure temperature as follows:

1. Inspect the thermometer daily before each field trip to ensure that there are neither cracks in the glass nor air spaces or bubbles in the mercury.
2. Allow the thermometer or in-flow multi-measurement system enough time to equilibrate to outside temperature when removed from a field vehicle.
3. Insert the thermometer into the parameter sample. Swirl the thermometer if the medium is calm and take the temperature reading when the reading stabilizes. If using an in-flow multi-measurement system, readings will be continuously displayed.
4. Record the temperature reading in the field logbook to the nearest $\pm 0.5^{\circ}\text{C}$.
5. Decontaminate the thermometer/ in-flow multi-measurement system and associated equipment in accordance with SOP No. 10 Decontamination.

6.0 DOCUMENTATION

Information required by this SOP will be documented on the Surface Water Data Sheet (Appendix C of the QAPP), Groundwater Data Sheet (Appendix C of the QAPP) and field logbooks. Use of these forms is described in SOP No. 8 Surface Water Sampling or SOP No. 6 Groundwater Sampling. Data required to be documented by this SOP include calibration checks, verifications, calibrations, factory calibration records, and measurements of temperature, dissolved oxygen, pH, specific conductivity, Eh, turbidity, and ferrous iron. In addition, the Field Measurement Data form (Appendix C) will be filled out to facilitate entry of the data into the project database.

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Surface Water Sampling

1.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes sampling equipment, sampling procedures, and documentation for collecting surface water samples from streams and seeps at and in the vicinity of the Midnite Mine Site. More than one sampling method may be required due to variable flow conditions at surface water collection locations. In consideration of these varied conditions, this SOP describes methods that are to be used based on site-specific flow conditions.

This SOP addresses the collection of ambient water quality samples. Sampling locations, sampling frequencies, and a list of analytes are specified in the Sampling and Analysis Plan (SAP).

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

Related SOPs cross-referenced by this SOP are as follows:

- SOP No. 10 Decontamination
- SOP No. 11 Sample Handling, Shipping, and Documentation.
- SOP No. 12 Surface Water Discharge in Streams and Seeps

4.0 EQUIPMENT NECESSARY FOR COLLECTING SURFACE WATER SAMPLES

4.1 GENERAL EQUIPMENT REQUIREMENTS

General equipment used for collecting surface water samples includes:

- Laboratory-provided sample containers
- Sample transfer devices
- Field logbook

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- Surface water data field sheets (Appendix C of QAPP)
- Stopwatch
- Plastic flagging
- Disposable latex gloves
- Appropriate health and safety equipment

Additional equipment for collecting filtered surface water samples includes:

- Beakers of assorted sizes
- Peristaltic pump and battery
- Tygon® or silicone tubing
- Disposable 0.45-micron filters

Equipment for sample handling and documentation includes:

- Sample labels
- Appropriate preservatives
- Chain-of-custody forms
- Clear plastic tape
- Fiber tape
- Custody seals
- Large (30 gallon) trash bag
- 1 Gallon Ziploc® freezer bags
- Cooler with sufficient ice to maintain a temperature of 4°C
- Shipping documentation

4.1.1 Laboratory-Provided Sample Containers

Wherever possible, laboratory-provided sample containers will be used to collect water quality samples. Alternatively, the containers may be purchased from a supplier who certifies that bottles have been pre-cleaned to EPA specifications. Records of container certification will be kept for these containers.

4.1.2 Sample Transfer Devices

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Beakers or dippers, composed of Teflon®, stainless steel or glass, may be used if site conditions or the use of pre-preserved sample containers prevent sampling by sample container immersion. The selected type of transfer device, the composition of this device, and the volume of the device will be recorded in the field notes.

5.0 SURFACE WATER COLLECTION METHODS

Surface water flow conditions vary geographically and seasonally. Therefore, the following list may be used as a guideline in identifying techniques of sampling which will correspond to the sample site flow conditions.

The flow conditions which have been most frequently encountered at the site, and sections of this SOP containing methods to be used at these sites, are:

1. Flowing, channelized streams:

Samples are to be collected by container immersion in accordance with Section 5.2, Stream Surface Water Sampling.

2. Spring and Seep Areas:

Samples are to be collected in accordance with Section 5.3, Sampling of Standing Water.

3. Low Flow Conditions:

Samples will be obtained in accordance with Section 5.4, Sampling of Seeps or other Low Flow Conditions.

Surface water samples are to be collected as grab samples. Grab samples characterize a medium at a particular point in space and time. Grab water samples are collected by sample container immersion or by using a transfer device, such as a beaker or dipper.

5.1 PROCEDURES

Samples will be collected from the same cross-section of the stream as that used for the discharge measurement (See SOP No. 12 Surface Water Discharge in Streams and Seeps). Always collect samples prior to making discharge measurements. Sediment samples will also be collected in the vicinity of some surface water sampling locations. Surface water sampling should also precede sediment sampling.

5.1.1 Sample Collected by Container Immersion

Empty sample bottles that contain no preservatives may be used to collect surface water samples by container immersion. To collect samples by container immersion, submerge the sample bottle below the water surface with the opening pointed upstream at the midpoint of the stream flow. Minimize the

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disturbance of bottom materials and fill the container to the desired volume. Preserve the sample, if necessary (as specified in the QAPP), cap the container and decontaminate the container's outside surface. Check the pH of preserved samples.

The sample pH will be checked by loosening the sample lid slightly, tipping the container until drops of liquid are visible on the lid threads, and testing the liquid drops with pH paper.

5.1.2 Sample Collected by Sample Transfer Device or Peristaltic Pump

If sample bottles are pre-preserved or site conditions prevent sample collection by container immersion, sample transfer devices or peristaltic pumps may be used for sample collection. The device is placed with the opening upstream at the midpoint of the stream flow. The sample will be poured directly from the beaker or dipper into the sample container. Alternatively, if a pump is used the water should be pumped directly into sample containers. The sampler will attempt to minimize the disturbance of bottom materials.

5.2 STREAM AND HIGH-FLOW SEEP SAMPLING PROCEDURES

The following section describes procedures for collecting samples from surface water streams and high-flow seeps. Seeps will be considered high-flow if samples can easily be collected without significant disturbance of sediment and other material at the sample point. Low-flow seeps will be sampled as described in Section 5.3.

If surface water flow will subsequently be measured (see SOP No. 12 Surface Water Discharge in Streams and Seeps), collect samples at the cross-section of the stream that will be used to measure discharge. Always collect the samples for chemical analysis before measuring discharge.

Collect surface water samples as follows:

1. Obtain all necessary sample collection and filtering equipment.
2. Decontaminate non-disposable sampling equipment as specified in SOP No. 10 Decontamination.
3. Make sure that the sample labels have been filled out for the sampling location (if labels used).
4. Obtain bottles for filling.
5. Place labels on the sample bottles and secure the labels with clear plastic tape, or write required information directly on bottles.
6. Wear clean, disposable latex gloves at all times when collecting samples.
7. Make sure that no activities are occurring or have recently occurred immediately upstream that would affect the integrity of the sample. Wade, if necessary, to the sample collection point (i.e., midpoint of the stream cross section) from a downstream location. To avoid disturbing stream sediments or otherwise contaminating samples, stand downstream of the location from which you

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collect. When collecting samples at successive locations, always proceed from downstream to upstream locations.

8. The open end of the sample bottle, sample transfer device, or pump tubing shall face upstream during stream sample collection.
9. Triple rinse the water collection device (e.g., beaker or dipper) with sample water, or pump 100 to 200 mL of sample water through tubing/filter to rinse. If not enough sample water is available to perform the triple rinse, then at a minimum, a single rinse will be performed and will be recorded in the field logbook and/or data sheet.
10. Directly fill sample bottles for unfiltered samples by container immersion, sample transfer, or pumping, as necessary. Fill filtered sample bottles with a peristaltic pump, tubing, and filter through a 0.45 micron filter by pumping directly from the stream or seep or from an intermediate container (i.e., a decontaminated beaker or intermediate sample bottle). At sites not readily accessible, both unfiltered sample bottles and intermediate sample bottles shall be filled at the sample site, transported back to the vehicle, and filtered from the intermediate bottles into new sample bottles. Sample bottles used as intermediate containers shall not be reused, but shall be discarded.
11. Measure field parameters described in the SAP using an in situ probe or by testing a separate aliquot of the unfiltered sample in accordance with SOP No. 7 Field Parameter Measurements.
12. Preserve the samples as specified in SOP No. 11 Sample Handling, Shipping, and Documentation.
13. Wipe clean the outside surface of all sample containers.
14. Place the samples in plastic bags.
15. Place the samples on ice in a cooler.
16. Record the date and time of sampling.
17. Complete field documentation and chain-of-custody form(s).

5.3 SAMPLING OF SEEPS OR OTHER LOW-FLOW CONDITIONS

Flow conditions at surface water sampling sites vary seasonally. Some of the sites may have low discharges with depth of flow being less than 0.5 inch. Field personnel will attempt to obtain samples of water at these sites by use of a transfer device. Field personnel will attempt to minimize the disturbance of bottom materials.

Sample containers will be filled as long as it is possible to dip water from the small stream into a beaker without disturbing bed materials. If flow is so low that all sample bottles cannot be filled, collect as many samples as possible and record the site flow conditions. Surface water sites with a flow depth less than 0.5 inch and no defined channel (i.e., seeps), are known to exist. Field crews may attempt to obtain water samples at such sites as follows:

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1. Dig a small depression in the soil within the path of flow.
2. Place a stainless steel bowl in this depression, with the rim of the bowl below the water surface.
3. Allow the bowl to become full of water, to overflow, and to continue to overflow for several minutes until the water is no longer turbid.
4. Obtain samples from the bowl by container immersion or by the dip and transfer method.
5. Repeat steps 2 through 4 until adequate sample volume is obtained.
6. When collecting unfiltered samples, triple rinse and fill the unfiltered sample bottles directly by immersion in the stream or seep flow if possible. If not enough sample water is available to perform the triple rinse, then at a minimum, a single rinse will be performed and will be recorded in the field logbook and/or data sheet. If unfiltered bottles cannot be filled due to low water depth, use the peristaltic pump and tubing to pump sample water into sample bottles or use a beaker to fill the unfiltered sample bottles, being careful to minimize sediment. Fill filtered sample bottles with a peristaltic pump, tubing, and filter through a 0.45 micron filter by pumping directly from the stream or seep or from an intermediate container (i.e., a decontaminated beaker or intermediate sample bottle). At sites not readily accessible, both unfiltered sample bottles and intermediate sample bottles shall be filled at the sample site, transported back to the vehicle, and filtered from the intermediate bottles into new sample bottles. Sample bottles used as intermediate containers shall not be reused, but shall be discarded.
7. Wear clean, disposable latex gloves at all times when collecting samples.
8. Measure field parameters described in the SAP using an in situ probe or by testing a separate aliquot of the unfiltered sample in accordance with SOP No. 7 Field Parameter Measurement.
9. Preserve the samples as specified in SOP No. 11 Sample Handling, Shipping, and Documentation.
10. Decontaminate the outside surface of all sample containers.
11. Place the samples in plastic bags.
12. Place the samples on ice in a cooler.
13. Record the date and time of sampling.
14. Complete field documentation and chain-of-custody form(s).

6.0 DOCUMENTATION

6.1 SURFACE WATER SAMPLING DOCUMENTATION

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Complete a surface water data sheet (Appendix C of the QAPP) for surface water samples at each sampling location. Be sure to completely fill in the data sheet. If items on the sheet do not apply to a specific location, label the item as not applicable (NA). The information on the data sheet includes the following:

- Sampling location
- Date and time of sampling
- Weather conditions
- Person(s) performing sampling
- Field parameter measurements, date and time
- Field meters used and calibration information
- Sample identification number(s)
- QA/QC samples taken at the location
- Method of sample collection (e.g., poly dipper).

In addition to the field sheets, samplers will record sampling information on the Monitoring/ Sampling Location Information log and Sample Collection Information log (Appendix C).

6.2 FIELD NOTES

All surface water sampling information will also be recorded in a bound field logbook. Record the following information using waterproof ink:

- Names of sampling personnel
- Weather conditions
- Date and time of sampling
- Sampling location
- Decontamination information
- Calibration information, sample methods used, or reference to the appropriate SOP
- Field parameter measurements
- Sample identification number(s)
- Method of sample collection
- Any other pertinent information that may have a bearing on sample quality.

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Sediment Sampling

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes composite and point sampling procedures to be used in the collection of surface and near surface sediment samples at and in the vicinity of the Midnite Mine Site. Sampling locations, sampling frequencies, and a list of analytes are specified in the Quality Assurance Project Plan (QAPP).

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

Related SOPs cross-referenced by this SOP are as follows:

- SOP No. 10 Decontamination
- SOP No. 11 Sample Handling, Shipping, and Documentation.

4.0 EQUIPMENT NECESSARY FOR COLLECTING SEDIMENT SAMPLES

General equipment used for collecting sediment samples includes:

- Laboratory provided sample containers (see SOP No. 11 Sampling Handling, Shipping, and Documentation)
- Bound field logbook
- Sample data sheets (Appendix C of the QAPP)
- Plastic flagging
- Stainless steel soil coring tool, 1 or 2-inch diameter
- Stainless steel No. 10 sieve
- Shovel (if sampling rocky areas)

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- Stainless steel mixing bowl and spoon
- Small sealable plastic bags
- Appropriate health and safety equipment.
- Appropriate decontamination equipment (see SOP No. 10 Decontamination)

Equipment for sample labeling, packing, documentation, and performing chain-of-custody procedures includes:

- Sample labels
- Chain-of-custody forms
- Clear plastic tape
- Fiber tape
- Custody seals
- Large (30 gallon) trash bag
- Gallon sealable bags
- Cooler with sufficient ice to maintain a temperature of 4°C
- Shipping documentation

5.0 SEDIMENT SAMPLING PROCEDURES

The SAP (Appendix A of the QAPP) identifies proposed sediment sampling locations on tables and figures. The proposed sample locations are approximate and will be finalized during the field investigation. Either composite, or both composite and grab samples will be collected at sample locations as indicated in the SAP. Section 5.1 describes the procedures for sample collection, and compositing of samples. Section 5.2 describes procedures for collecting grab samples.

5.1 COMPOSITE SEDIMENT SAMPLING

Each composite sediment sample will be comprised of six subsamples collected from two stream channel cross-sections along identified stream reaches. The stream reaches will be identified based on proposed sample locations presented in the SAP, and should be located in the same relative positions to stream features (e.g., confluences, tributaries) as the mapped proposed sample points. For example, if on the sampling location map, a proposed sample point is shown just downstream of the confluence between a tributary and the main stem of a stream, the reach of the stream where the composite sample is collected should also be located just downstream of the confluence. In this case, no part of the

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stream reach to be sampled should extend upstream of the confluence. Also, no part of the stream reach should extend downstream of a major tributary entering the main stem.

Each composite sediment sample stream reach will be approximately 120 meters long and will include areas of sediment deposition. The stream reach and cross-sections of the stream where subsamples of the composite will be collected will be delineated during a reconnaissance of the sample site using the following procedure:

- Find the approximate location of the proposed sample point as shown in the SAP.
- Visually observe the streambed from approximately 60 meters downstream of the proposed sample point to approximately 60 meters upstream of the point.
- Identify two cross-sections of the stream within the 120-meter long reach where fine-grained sediments are visible and can be sampled.

Once identified, the cross-sections of the stream should be marked for sample collection and surveying.

Three subsamples of the fine-grained sediments will be collected within each of the two identified cross-sections. If possible, one subsample should be collected near each of the two stream banks, and one sample should be collected near the center of the channel. It may be necessary to adjust the subsample locations due to the availability of fine-grained sediments. The subsamples will be collected from the interval between the surface and 20 cm below the surface. The subsamples will be collected and composited as described below:

1. Decontaminate all sediment sampling equipment prior to sample collection and between sampling sites in accordance with SOP No. 10 Decontamination.
2. Locate the subsample location within the stream cross-section.
3. Using a stainless steel coring tool or spoon, collect at least 200 grams of sediment from the 0 to 20 cm depth interval.
4. Sieve the sediment subsample using the No. 10 mesh sieve to remove any cobbles, large pebbles, pieces of vegetation, or other material.
5. Place a pre-determined equal volume of the sieved sediment subsample into a stainless steel bowl.
6. Repeat steps 2-5 for each subsample in the stream cross-section.
7. Repeat steps 2-6 for the second stream cross-section.
8. Scrape the sediment from the sides, corners, and bottom of the stainless steel mixing bowl with a stainless steel spoon and roll the sediment to the center of the bowl.
9. Thoroughly mix the sediment sample and continue until the mixture is as homogeneous as possible.

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Note: If water is present in the sample mixture that is obtained by use of a sludge or core sampler, then an attempt will be made to preserve the water-to-solid ratio by including the water as part of the sample.

10. Use the stainless steel scoop to place homogenous sample/water mixture into each sample container.
11. Remix the sample/water mixture remaining in the mixing bowl after each scoop of material is placed in a sample container.
12. Partially fill each sample container (approximately in thirds), then add additional sample to each container. See the SAP for sample analysis and container requirements. Continue in this manner until all containers have been filled. This approach is used to evenly distribute the liquid into the various sample containers, while endeavoring to maintain the solid-to-liquid ratio present in the samples collected in the core sampler.
13. If the mixture is high in liquid content, pour the mixture into a stainless steel beaker to more efficiently transfer the mixture into sample containers. Continue mixing with a spoon to maintain homogeneity of the sample mixture during filling of sample containers.
14. Decontaminate the outside surface of all sample containers.
15. Place the sample containers in sealable bags.
16. Place the sealable bags in a garbage bag.
17. Place the samples on ice in a cooler.
18. Record the date and time of sampling.
19. Complete field documentation and chain-of-custody form(s).
20. Decontaminate sampling equipment in accordance with SOP No. 10 Decontamination.

5.2 GRAB SEDIMENT SAMPLING

Grab sediment samples will be collected in addition to composite samples at sampling locations indicated in the SAP. The grab samples will be collected from points within the stream reaches delineated for composite sampling. In most cases, the sediment sample locations will also be co-located with surface water sample locations. When this occurs, the grab sediment sample location should also be suitable for surface water sampling and discharge measurement, if possible. Once identified, the grab sample point should be marked for sample collection and surveying.

The grab sediment sample will be collected from the interval between the surface and 10 cm below the surface following these procedures:

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1. Decontaminate all sediment sampling equipment prior to sample collection and between samples in accordance with SOP No. 10 Decontamination.
2. Collect representative sediments from the 0 to 10 cm interval from the stream bed using a stainless steel spoon and transfer into the stainless steel mixing bowl. Collect sufficient sample to fill an 8 ounce glass jar. Note that if sediments are to be sampled at locations where surface water samples are to be collected, the surface water sample should be collected first to avoid disturbance of the streambed.
3. Sieve sediment samples using the No. 10 mesh sieve to remove any cobbles, large pebbles, pieces of vegetation, or other material.
4. Scrape the sediment from the sides, corners, and bottom of the stainless steel mixing bowl with a stainless steel spoon and roll the sediment to the center of the bowl.
5. Thoroughly mix the sediment sample until the mixture is as homogeneous as possible.

Note: If water is present in the sample mixture that is obtained by use of a stainless steel spoon, then an attempt will be made to preserve the water-to-solid ratio by including the water as part of the sample.

6. Use the stainless steel spoon to place the homogenous sample/water mixture into each sample container.
7. Remix the sample/water mixture remaining in the mixing bowl after each scoop of material is placed in a sample container. This approach is used to evenly distribute the liquid into the sample container, while endeavoring to maintain the solid-to-liquid ratio present in the sample collected.
8. If the mixture is high in liquid content, pour the mixture into a stainless steel beaker to more efficiently transfer the mixture into sample containers. Continue mixing with a spoon to maintain homogeneity of the sample mixture during filling of sample containers.
9. Decontaminate the outside surface of all sample containers.
10. Place the samples in sealable freezer bags.
11. Place the sealable bags in a garbage bag.
12. Place the samples on ice in a cooler.
13. Record the date and time of sampling.
14. Complete field documentation and chain-of-custody form(s).
15. Decontaminate sampling equipment in accordance with SOP No. 10 Decontamination.

6.0 DOCUMENTATION

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All information pertaining to sediment sampling shall be recorded in a bound field logbook with consecutively numbered pages. Corrections shall be made by line-out deletions that are initialed and dated. Sediment collection information will be recorded on the sediment sampling data sheet (Appendix C of the QAPP). The information recorded shall include the following, as appropriate:

- Name(s) of field personnel
- Date and time of entry, and physical/environmental conditions during field activity
- Location description, and log of photographs (if taken)
- Sampling equipment and method used
- Information concerning sampling decisions
- Samples collected, intervals, types, and identification number
- Field observations
- Summary of daily tasks and information concerning sampling changes and scheduling modifications
- Sample preparation procedure
- Signature and date by personnel responsible for procedures.

In addition, the Sample Collection Information and Monitoring/Sampling Location logs (Appendix C) will be filled in to facilitate entry of sampling data into the project database.

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Decontamination

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Decontamination

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the Standard Operating Procedure (SOP) for decontamination of personnel and equipment during the Midnite Mine Remedial Investigation/ Feasibility Study (RI/FS) field program. This SOP will be used in conjunction with the Quality Assurance/Quality Control (QA/QC) Plan, Sampling and Analysis Plan, and Health and Safety Plan.

The overall objective of environmental sampling programs is to obtain samples that are representative of conditions within the sampled medium at the sample location. Extraneous contaminant materials can be introduced into the sample medium of interest during the sampling program (e.g., by contacting water with equipment previously contaminated at another sampling site). Trace quantities of contaminants can thus be captured in a sample and lead to false positive analytical results and, ultimately, to an incorrect assessment of the contaminant conditions. Decontamination of personnel, sampling equipment (e.g., pumps, tubing, and soil and sediment sampling equipment), and field support equipment (e.g., drill rigs and vehicles) is therefore required to minimize the possibility of sampling cross-contamination, exposure to personnel and transport of contaminated material to clean areas.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

The procedures for decontamination set forth in this SOP are intended for use with nearly all the other SOPs.

4.0 EQUIPMENT NECESSARY FOR DECONTAMINATION

The following is a list of equipment that will be necessary to perform decontamination activities:

- Laboratory wash bottles
- Brushes
- Wash tubs (plastic)

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- Buckets (plastic)
- Thin window Geiger-Muller detector
- Scrapers
- High-pressure, hot water washer
- Paper towels
- Liquinox™ detergent (or equivalent)
- Potable water
- Deionized or distilled water
- 10 percent nitric acid solution
- Reagent grade methanol solution
- Water sprayers
- Appropriate personal protective equipment (PPE)
- Disposable latex gloves
- Clean plastic sheeting and/or trash bags.

5.0 DECONTAMINATION PROCEDURES

Decontamination will be performed during the field investigation to decontaminate personnel, sample containers, sampling equipment, and heavy equipment. Specific areas where these activities will occur, the methods to be used, and other specifications are described in the following sections.

5.1 PERSONNEL DECONTAMINATION

Decontamination procedures for field personnel shall take place prior to individuals entering the support zone (e.g., field trailer), leaving the site, and as needed based on field conditions and events. Personnel decontamination will be performed at a location near the field trailer that will be designated during field mobilization. The decontamination process will include:

- Washing boots or boot covers with detergent solution and rinsing
- Removing PPE coveralls and boot covers (if used) and disposing of them in a specified used PPE container or plastic trash bag
- Removing hard hat and other safety equipment (e.g., protective eyewear), washing with detergent solution, and rinsing

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- Radiological screening (frisking) of personnel (see the site Health and Safety Plan for procedures)
 - Removing latex gloves and disposing of them in a specified used PPE container or plastic trash bag
- Hands, face, and forearms should be washed with soap and water or anti-bacterial wipes before eating or drinking.

5.2 DECONTAMINATION OF SAMPLING CONTAINERS AND EQUIPMENT

Procedures for decontamination of sampling equipment apply to: equipment that is re-usable and contacts a sampled medium, including delicate equipment and water level probes; and, sample bottles and coolers. Disposable items such as disposable filters and tubing that are certified clean by the manufacturer are not subject to decontamination requirements. Decontamination of sampling equipment will in general be performed at individual sample locations. However, any pre-rinsing or decontamination of equipment prior to sampling can be performed at other locations suitably set up for decontamination (i.e., with wash and rinse tubs).

General requirements for decontamination of re-usable sampling equipment are described below:

- All equipment that will contact a sampled medium will be decontaminated before and after use.
- New latex gloves will be worn when performing equipment decontamination
- Wash/rinse tubs will be decontaminated before initial use and between sampling sites
- Detergent and rinse solutions to be used for decontamination procedures, unless in water sprayers, will be replaced with new solutions between sampling sites. In some cases, new solutions may be needed between the collection of samples at the same location.
- Following decontamination, equipment will be placed in a clean area or on clean plastic sheeting to prevent contact with soil. If the equipment will not be used immediately, the equipment should be covered or wrapped with plastic sheeting or heavy duty trash bags to minimize potential airborne contamination.

Specific procedures for decontaminating sampling equipment are listed below.

- Scrape off gross contamination from equipment at the sampling site and place in container for soil investigative derived waste (IDW).
- Place the equipment in a wash tub containing detergent solution or spray the equipment with a detergent solution contained within a water sprayer, and scrub the equipment with a bristle brush or similar utensil (if possible).
- Triple rinse the equipment with deionized or distilled water from a water sprayer or wash bottles.

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- Rinse equipment with 10 percent nitric acid solution or reagent grade methanol as applicable (nitric acid will apply when samples will be collected for metals analysis, methanol rinse will apply when samples will be collected for semi-volatile compounds analysis).
- Re-rinse the equipment with deionized or distilled water (note that if time allows for air drying after methanol rinse, do not perform this step).
- Allow equipment to gravity drain or air dry.
- Frisk the equipment with a thin window Geiger-Muller detector in accordance with the Health and Safety Plan. If elevated readings are encountered (i.e., 1000 disintegrations per minute above background), additional decontamination is required.

Water sprayers should be labeled to comply with the hazard communication program and avoid use of the wrong solutions in the decontamination process. Decontamination fluids and solid IDW should be managed as described in the project SAP.

Well pumps will be decontaminated using a similar succession of rinse steps as described below. However, nitric rinse solutions should be approximately 1 percent instead of 10 percent to avoid corroding the pump. The rinse solutions will be pumped into a container for IDW water using the pump.

Sample containers will be decontaminated as necessary and radiologically screened in accordance with SOP No. 11 Sample Handling, Shipping, and Documentation before the containers are packed and shipped to an analytical laboratory.

Decontaminating Delicate Equipment and Water Level Probes

Equipment susceptible to water damage shall be carefully cleaned by wiping successively with paper towels wetted with detergent solution, approved water, and deionized or distilled water. Be sure to avoid damaging the equipment.

Decontaminate water level probes by wiping with wetted towels as described above while winding the probe tape onto its spool. Rinse the water level probe with deionized or distilled water before use. Store the water level probe in a clean plastic bag after decontamination.

5.3 DECONTAMINATION OF HEAVY EQUIPMENT

Decontamination of heavy equipment, such as drilling equipment (augers, drill rigs) and field vehicles, shall take place at a designated decontamination area located at the south end of Pit 3. Decontamination shall take place such that all wash and rinse water will drain into Pit 3. The following steps shall be used to decontaminate drilling and heavy equipment:

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- Gross contamination or drill cuttings that are caked on will be scraped off equipment with a flat-bladed scraper or shovel at the sampling or borehole location and collected. Containerize the soil waste and handle as described in the project SAP.
- Personnel shall dress in suitable safety equipment in the decontamination area (e.g., gloves and safety glasses or splash shields).
- Equipment such as drill rigs, augers, drill bits, and shovels will be sprayed with a detergent solution and then rinsed with approved water. Care shall be taken to adequately clean the insides of hollow-stem augers. A high-pressure, hot water washer will be used to decontaminate heavy equipment.
- Frisk the equipment with a thin window Geiger-Muller detector in accordance with the Health and Safety Plan. If elevated readings are encountered (i.e., 1000 or greater disintegrations per minute above background), additional decontamination is required.
- Following decontamination, drilling equipment shall be placed on the clean drill rig. If the equipment is not used immediately, it shall be stored in an area where it will remain clean. If necessary, equipment storage racks on drill rigs will be cleaned or covered with clean plastic sheeting to assure that decontaminated equipment is not placed in dirty areas for storage.

6.0 DOCUMENTATION

Sampling personnel shall be responsible for documenting the decontamination of sampling and drilling equipment. The documentation shall be recorded with waterproof ink in the sampler's field logbook. The information entered in the logbook concerning decontamination shall include the following:

- Decontamination personnel
- Date
- Decontamination observations and procedures

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Sample Handling, Shipping, And Documentation

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Sample Handling, Shipping, And Documentation

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to handle, ship and document samples collected during the Remedial Investigation/Feasibility Study (RI/FS) at the Midnite Mine Site, Spokane Indian Reservation, Washington.

This SOP is intended to accommodate shipping samples to privately contracted laboratories. If samples are collected for shipment to laboratories procured through the Environmental Protection Agency (EPA) Contract Labs Program (CLP), then see EPA document EPA/540/R-96/032 *Sampler's Guide to the Contract Laboratory Program* for additional handling and shipping information.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. U.S. Department of Transportation and International Air Transport Association regulations require that employees involved with transporting hazardous materials complete specific training requirements. Site personnel will be trained regarding hazardous materials transportation prior to shipment of any hazardous materials. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

Related SOPs cross-referenced by this SOP include:

- SOP No. 10 Decontamination

4.0 EQUIPMENT NECESSARY FOR SAMPLE HANDLING, SHIPPING, AND DOCUMENTATION

The following equipment will be used for sample labeling, packing, documentation, and Chain-of-Custody procedures:

- Personal protective equipment (PPE) as outlined in the Health and Safety Plan (HSP)
- Radiological monitoring equipment (Ludlum Model 19 Micro R Meter or equivalent)

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- Decontamination equipment and supplies (see SOP No. 10 Decontamination)
- Clean sample containers (e.g., glass polyethylene, etc.) with preservatives, if required, as specified in the Quality Assurance Project Plan (QAPP), Section 2.4
- Shipping coolers
- Ziplock or equivalent plastic bags
- Self-adhesive sample labels
- Shipping forms (provided by shipping courier)
- Shipping labels (e.g. Fragile, This Side Up, etc.)
- Sample labels (see Appendix C of the QAPP)
- Chain-of-Custody forms (see Appendix C of the QAPP)
- Custody seals (see Appendix C of the QAPP)
- Bubble wrap or equivalent packing material
- Tape (clear tape and packing tape)
- Ice
- Paper towels
- Large trash bags

5.0 SAMPLE HANDLING, SHIPPING, AND DOCUMENTATION PROCEDURES

5.1 SAMPLE IDENTIFICATION

Samples collected during site activities will have unique sample identification (ID) numbers. These numbers are necessary to identify and track each sample collected for analysis during the project. In addition, the sample ID numbers will be used in the database to identify and retrieve the analytical results received from the laboratory. The sample ID plan is presented in Section 3 of the Sampling and Analysis Plan (SAP [Appendix A of the QAPP]).

5.2 SAMPLE LABELING

Sample labels will be filled out partially before field sampling activities begin. An example of sample labels is presented in Appendix C of the QAPP. The date, time, sample depth, and sampler's initials or signature should not be completed until the time of sample collection. Sample labels will be filled out using waterproof ink. At a minimum, each label will contain the following information:

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- Site location
- Sample ID number
- Sample type
- Date and time of sample collection
- Analyses required
- Method of preservation (if any)
- Sample matrix
- Sampler initials

After the label is completed and attached to the sample container, clear plastic tape will be placed over the label to protect and secure it to the container. Care must be taken during labeling and taping to preclude the possibility of sample contact with label or tape adhesive.

5.3 SAMPLE HANDLING

This section discusses proper sample containers, preservatives, and handling and shipping procedures. Much of the information in this section is also presented in the QAPP. Table 1 summarizes sample analyses, containers, preservation and holding times.

5.3.1 Sample Containers

As available, certified, commercially clean sample containers will be obtained from a subcontracted analytical laboratory or vendor. Required preservatives may be prepared and placed in the bottles at the laboratory before shipment to the site. Alternatively, sample preservatives will be added at the site prior to shipment of samples to the laboratories. Appropriate sample containers are discussed in the QAPP and summarized in Table 1 of this SOP.

5.3.2 Sample Preservation

All samples will be stored on ice in an insulated cooler to maintain a temperature of 4°C immediately following sample collection. Soil samples do not require additional preservation. As noted above, sample containers for aqueous samples will either be obtained from the laboratory containing the appropriate preservatives or the appropriate preservatives will be added to the bottles at the site.

5.3.3 Radiological Screening

Each sample container must be decontaminated per the requirements of SOP No. 10 Decontamination, prior to transport of samples to support zones or off-site.

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Following decontamination, each sample container will be frisked using a thin window Geiger-Muller detector, or equivalent, on the surface of the sample container. If elevated readings (i.e., 1000 or more disintegrations per minute above background) are detected, the container will be decontaminated again. If elevated readings are not indicated, and no other hazardous characteristics are identified, no additional container decontamination is required and the material may be shipped per the requirements of Section 5.3.4 of this SOP.

If elevated readings are detected from the sample container after it has been decontaminated again, a label that indicates “radioactive” and the maximum reading must be placed on the inside of the sample cooler. After the cooler is packed, meter readings must be taken across all external surfaces of the closed sample cooler. If the readings do not exceed 0.5 millirem per hour, include the following statement on a regular airbill:

“Radioactive material, excepted package – limited quantity of material”

Additionally, the following notice must be placed in the cooler:

“This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, exempted package – limited quantity of material – UN2910”

The package is exempted from additional requirements and the samples may now be shipped per the requirements of Section 5.3.4 of this SOP.

If readings greater than 0.5 millirem per hour are detected on any external surface of the cooler, attempt to separate or shield samples so that readings of less than 0.5 millirem per hour may be achieved. When packaging the samples, be sure to eliminate the potential for shifting during transport which could result in readings outside the package exceeding 0.5 millirem per hour. If readings of less than 0.5 millirem per hour cannot be achieved, the samples must be shipped per the requirements of section 5.3.4.1.

5.3.4 Sample Packaging and Shipping

Samples and sample containers will be packaged properly to prevent breakage of containers and leakage of contents. Samples that pass the radiological screening (i.e., frisking) criteria described in Section 5.3.3 will follow the packaging and shipping procedure presented below. Samples that do not pass the radiological screening criteria will follow procedures presented in Section 5.3.4.1.

- If the sample container is glass, wrap individual sample containers with bubble wrap.
- For Marinelli beakers used to collect samples for radon analysis, the lids shall be sealed to the containers using electrical tape. Specifically, place electrical tape around the area where the lid meets the container by winding around the circumference three to four times.
- Place sample containers in recloseable plastic bags.

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- Place sufficient amounts of bubble wrap in the bottom and sides of the shipping cooler to prevent movement of contents.
- Line the inside of the cooler with a plastic trash bag, add enough ice (in double bags) to the cooler to maintain the required temperature of 4°C. Line the bottom, sides, and top of cooler to ensure proper shipment temperature. Using at least 3-4 one gallon bags of ice per 48-quart cooler is recommended.
- A bottle containing tap water and identified as a temperature blank will be included with each cooler containing samples cooled to 4°C. Upon receipt of the samples at the laboratory, the temperature blank will be used to determine the cooler temperature. The temperature blank will not be assigned a sample identification number and will not appear as a line item on the chain-of-custody form.
- Place samples and temperature blank inside the bag in an upright position. Tie shut the trash bag holding the samples and ice.
- Fill excess space in the cooler with packing material (e.g., bubble wrap) to prevent movement of sample containers.
- Place the original and yellow copy of the chain-of-custody (COC) form inside a plastic bag, and tape the bag inside the cooler lid.
- Close the cooler lid, and seal the cooler and the cooler spout with appropriate packaging tape.
- Place two custody seals (tampering seals) on the cooler in separate areas over (across) the seal between the lid and the cooler base. Tape the custody seals to the cooler to ensure that custody seal is adequately affixed.

A shipping bill should be completed for the shipper and taped to the top of the cooler using the envelope provided by the shipper. The following markings will also be placed on the top of the cooler:

- This End Up
- Fragile
- Laboratory delivery address
- Sender's return address

The pink copy of the shipping bill will be retained by the Site Manager for attachment to the corresponding COC form. Samples will be hand delivered or shipped by express courier for delivery to the analytical laboratory. The Sample Manager is responsible for verifying that samples collected by the field team have been properly packed in coolers and for verifying the accuracy and completeness of sample labels and COC forms.

The following is a summary of steps to be followed to check that sample management and paperwork is complete:

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- Verify sample labels.
- Check or complete the COC form.
- Pack samples in cooler and verify COC form accuracy.
- Verify that labels and forms meet shipping requirements.
- Photocopy the COC form and retain two copies for the project files.
- Send original and yellow copy of the COC form to the laboratory.
- Obtain pink copy of the shipping bill and staple it to the corresponding COC copy.

No samples will be shipped for Sunday delivery. Saturday delivery to the laboratory will require laboratory approval before shipment.

5.3.4.1 Shipping Samples Above Radiological Screening Criteria

Refer to the classification, identification, packing, labeling, documentation and shipping requirements specified in the current versions of the International Air Transport Association “Dangerous Goods Regulations” and U.S. Department of Transportation “Hazardous Materials Regulations” as applicable.

Copies of these regulations will be available in the on-site project file; additional guidance can be obtained by contacting the Project Health and Safety Officer.

5.3.5 Sample Container Tampering

If, at any time after samples have been secured, custody seals on the cooler are identified as having been tampered with, the following procedures will be conducted:

- Check with personnel having access to sample coolers to evaluate whether inadvertent tampering can be documented.
- Document findings of the incident in a logbook.

If it cannot be documented that inadvertent breaking of the custody seal that did not affect the integrity of samples has occurred, the samples will be re-collected and the Project Manager and QA Officer will be notified.

5.3.6 Holding Times and Analyses

The holding time is specified as the maximum allowable time between sample collection and analysis or extraction, based on the analyte of interest, stability factors, and preservative (if any) used. The sample analyses and corresponding holding times are summarized in Table 1.

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6.0 DOCUMENTATION

This section describes documentation required in the field notes and sample COC requirements.

6.1 FIELD NOTES

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded on field sampling data sheets, and, in a permanently bound weatherproof field notebook with consecutively numbered pages. The information on field sampling data sheets or in the field notebook will include the following as a minimum. Additional information is included in the specific SOPs regarding the appropriate data sheets.

- Project name
- Location of sample
- Sampler's signature
- Date and time of sample collection
- Sample identification numbers and sample depth (if applicable)
- Description of samples (matrix sampled), composite or grab sample
- Analysis to be performed
- Number and volume of samples
- Description of QA/QC samples (if collected)
- Sample methods or reference to the appropriate SOP
- Sample handling, including filtration and preservation, as appropriate for samples
- Field observations
- Results of any field measurements, such as depth to water, pH, temperature, and conductivity
- Decontamination information
- Calibration information
- Personnel present

Changes or deletions in the field notebook should be lined out with a single strike mark, initialed and dated by person making change, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the collector's memory.

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Each page of the field notebook will be signed by the person making the entry. Anyone making entries in another person's field book will sign and date those entries.

6.2 CHAIN-OF-CUSTODY PROCEDURES

The custody of all samples shall be documented on the COC forms. The COC forms document possession of the sample from collection through laboratory receipt. A sample COC form is shown in Appendix C of the QAPP.

Follow appropriate sample custody and documentation procedures precisely to preserve sample integrity and to ensure the validity of field and laboratory data. As a result, all sample data will be traceable from the time and location of sample collection through chemical analyses and to the time when data are used. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form.

The following minimum information will be recorded on the COC form:

- Sample ID
- Sampling date and time
- Required analysis
- Number of containers
- Sampler signature

The objective of the custody identification and control system for the samples is to ensure, to the extent practicable, that the following occur:

- All samples scheduled for collection are uniquely identified.
- The correct samples are analyzed and are traceable to their records.
- Important sample characteristics are preserved.
- Samples are protected from loss or damage.
- Any alteration of samples (e.g., filtration, preservation, and dilution) is documented.
- A record of sample integrity is established.
- Legally traceable custody and possession records are maintained.

For this project, a sample is defined as being in an individual's custody if the following conditions occur:

- The sample is in that individual's actual physical possession.
- The sample is in that individual's view after being in their physical possession.

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- The sample is in that individual's physical possession and then locked or otherwise sealed so that tampering would be evident.
- The sample is maintained in a secure area that is restricted to authorized personnel only.

General field custody procedures include the following:

- As few people as possible should handle samples.
- The field sampler is personally responsible for the care and custody of the samples collected until they are properly transferred.
- When transferring the samples, the individuals relinquishing and receiving the samples will document the transfer by signing, dating, and writing the time of transfer on the COC form.
- The person responsible for delivering the samples to the laboratory or to the shipping carrier will sign the COC form, retain the third copy of the form, document the method of shipment, and send the original and the second copy of the form with the samples.
- Custody seals shall be attached so that it is necessary to break the seal to open the shipping container. The person affixing the custody seal will sign and date the seal.

Observe general documentation rules, including the use of black ink. Make any changes to the COC form by drawing a single line through the incorrect material and initialing the markout. Put a line through and initial blank lines on the COC form.

Upon receiving the samples, the laboratory's representative shall do the following:

- Sign and keep copies of shipping documents.
- Sign the COC form and return the second copy to the Project Manager (may be included with the analysis results)
- Measure and document the temperature of the samples using temperature blank.
- Document the condition of the custody seals and of the samples.
- Notify the project manager if any breakage or improper preservation has occurred or if there is a discrepancy between the COC form, sample labels, and requested analyses.
- Provide copies of the above documentation to the project manager with the final laboratory data package.
- At the laboratory, custody of all samples will be in accordance with the laboratory QAP and SOP (QAPP, Appendix E) from sample receipt through sample residual disposal.

6.3 PHOTOGRAPHS

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When photographs, slides, or movies are taken for visual documentation of a site or procedure, they are numbered to correspond to the field logbook entries. If possible, a reference point (building, sign, etc.) is included in the photograph to assist in verifying the location of the photograph and provide an approximate scale. The name of the photographer, date, time, site location, direction viewed, and site description is entered sequentially in the logbook as photos are taken.

7.0 REFERENCES

International Air Transport Association. 1999. "Dangerous Goods Regulations," 40th Edition. Effective 1 January 1999.

U.S. Department of Transportation. 1999. 49 CFR Parts 172 and 173, "Hazardous Materials Regulations"

ASTM D-4840-88, Standard Practice for Sampling Chain-of-Custody Procedures, 1995 Annual Book of ASTM Standards, Vol. 04.08.

Table 1
SAMPLE ANALYSES, CONTAINERS, PRESERVATION AND HOLDING TIMES

Analytical Parameter (a)	Sample Matrix	Preservation	Number/ Minimum Volume of Container(s) (d)	Sample Hold Time (from collection)
VOC	Water	pH < 2 with HCl	2 40-ml VOA vials	14 days
TVPH	Water	pH < 2 with HCl	2 40-ml VOA vials	14 days
SVOC	Water	Cool to 4 °C	2 1-liter amber glass	7 days until extraction; 40 days after extraction
SVOC	Sediment	Cool to 4 °C	1 16-oz glass	14 days until extraction; 40 days after extraction
TEPH	Water	Cool to 4 °C	2 1-liter amber glass	7 days until extraction; 40 days after extraction
TEPH	Sediment	Cool to 4 °C	1 16-oz glass	14 days until extraction; 40 days after extraction
Total Metals	Water	pH < 2 with HNO ₃	1 1-liter poly	180 days
Metals	Sediment	Cool to 4 °C	1 16-oz poly or glass	180 days
Total Mercury	Water	pH < 2 with HNO ₃	1 500-ml poly	28 days
Mercury	Sediment	Cool to 4 °C	1 16-oz poly or glass	28 days
Diss. Metals	Water	pH < 2 with HNO ₃	1 1-liter poly	180 days
Diss. Mercury	Water	pH < 2 with HNO ₃	1 500-ml poly	28 days

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Analytical Parameter (a)	Sample Matrix	Preservation	Number/ Minimum Volume of Container(s) (d)	Sample Hold Time (from collection)
Ammonia	Water	2 ml of H ₂ SO ₄ for every liter and Cool to 4 °C	1 500-ml poly	28 days
Ammonia	Sediment	Cool to 4 °C	1 16-oz glass	28 days
Anions	Water	Cool to 4°C	1 250-ml poly	48 hours for NO ₂ , 28 days for all else
Anions	Sediment	Cool to 4°C	1 16-oz glass	28 days
Carbonate, Bicarbonate	Sediment	Cool to 4 °C	1 250-ml poly	14 days
pH	Water	NA	Poly or glass	Analyze Immediately
pH	Sediment	Cool to 4 °C	1 4 oz. Poly or glass	Analyze as soon as possible following receipt at laboratory
Temperature	Water	NA	Poly or glass	Analyze Immediately
Specific Conductance	Water	NA	Poly or glass	Analyze Immediately
Eh	Water	NA	Poly or glass	Analyze Immediately
Turbidity	Water	NA	Poly or glass	Analyze Immediately
Dissolved Oxygen	Water	NA	Poly or glass	Analyze Immediately
Ferrous Iron	Water	NA	Poly or glass	Analyze Immediately
TSS	Water	Cool to 4 °C	1 100-ml poly	7 days
TDS	Water	Cool to 4 °C	1 100-ml poly	7 days
TOC	Sediment	Cool to 4 °C	1 500-ml amber glass	28 days
Alkalinity	Water	Cool to 4 °C	1 250-ml poly	14 days
Hardness	Water	NA	NA (calculated)	NA
Total Phosphorus and Ortho phosphate	Water	2 ml of H ₂ SO ₄ for every liter and Cool to 4 °C	1 500-ml poly	28 days
Total Phosphorus and Ortho phosphate	Sediment	Cool to 4 °C	1 16-oz glass	28 days
COD	Water	pH < 2 with H ₂ SO ₄ Cool to 4 °C	1 100-ml poly	28 days
Particle Size Distribution	Sediment	None required	1 8-oz glass (e)	None
U-234, U-235, U-238	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months

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Analytical Parameter (a)	Sample Matrix	Preservation	Number/ Minimum Volume of Container(s) (d)	Sample Hold Time (from collection)
U-234, U-235, U-238	Sediment	None	2 1-liter poly (c)	6 months
Th-230	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Th-230	Sediment	None	2 1-liter poly (c)	6 months
Th-228, Th-232	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Th-228, Th-232	Sediment	None	2 1-liter poly (c)	6 months
Ra-226	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Ra-226	Sediment	None	2 1-liter poly (c)	6 months
Ra-228	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Ra-228	Sediment	None	2 1-liter poly (c)	6 months
Pa-231	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Pa-231	Sediment	None	2 1-liter poly (c)	6 months
Ac-227	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Ac-227	Sediment	None	2 1-liter poly (c)	6 months
Rn-222	Water	pH < 2 with HNO ₃	1 1-liter marinelli	4 days
Pb-210	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Pb-210	Sediment	None	2 1-liter poly (c)	6 months
Gross Alpha	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Gross Beta	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Th-232 Decay Series	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
Th-232 Decay Series	Sediment	None	2 1-liter poly (c)	6 months
U-235 Decay Series	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
U-235 Decay Series	Sediment	None	2 1-liter poly (c)	6 months
U-238 Decay Series	Water	pH < 2 with HNO ₃	3 1-gallon poly (b)	6 months
U-238 Decay Series	Sediment	None	2 1-liter poly (c)	6 months

Table 1 Footnotes:

- (a) All definitive methods and some screening methods will be conducted at an analytical laboratory. The following screening methods will be performed in the field at the time of sampling: pH (water only), temperature, specific conductance, Eh, turbidity, dissolved oxygen and ferrous iron.

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- (b) Assuming all radiological parameters are sent for analysis to the same laboratory, an aggregate volume of 3 gallons of water will be used to complete all radiological parameters except radon. One in ten samples collected will have an aggregate volume of 5 gallons for laboratory QC (MS/MSD, method duplicate).
- (c) Assuming all radiological parameters are sent for analysis to the same laboratory, an aggregate volume of 2 liters of sediment with a sieve size less than 1/8 inch will be used to complete all radiological parameters.
- (d) Parameters requiring the same preservation, similar container type and being analyzed by the same laboratory may be collected as one aggregate volume.
- (e) Collect an additional 8 oz volume for every tenth sample for laboratory QC.

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Surface Water Discharge In Streams And Seeps

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Surface Water Discharge In Streams And Seeps

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes methods for measuring surface water discharge in streams and seeps at and in the vicinity of the Midnite Mine Site. Surface water discharge measurements are expressed in units of cubic feet per second (cfs) or gallons per minute (gpm). This SOP outlines three methods that may be used for measuring discharge: (1) velocity-area method using flow meters, (2) permanently installed or portable flumes or V-notch weirs, or (3) volumetric method (time and volume or time and distance).

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

Related SOPs cross-referenced by this SOP are as follows:

- SOP No. 10 Decontamination
- SOP No. 8 Surface Water Sampling

4.0 EQUIPMENT NECESSARY FOR CONDUCTING SURFACE WATER DISCHARGE MEASUREMENTS

4.1 GENERAL EQUIPMENT REQUIREMENTS

General equipment used for conducting surface water discharge measurements includes:

- Stopwatch
- Bound field logbook
- Surface water sampling field data sheets (Appendix C of the QAPP)
- Plastic flagging

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Surface Water Discharge In Streams And Seeps

- Portable cutthroat flume with assorted throat sizes (only if a permanent flume or V-notch weir does not exist at the sampling location)
- Marsh-McBirney flow meter (or equivalent) and top setting rod (only if not using a flume or V-notch weir, or if flows are too high for the flume or V-notch weir)
- Small line level
- Shovel
- Fiberglass tape (50 foot) (only if using flow meter)
- Calibrated containers to measure flow
- 4-inch polyvinyl chloride (PVC) pipe (only if flows are too low for flume or not using flume or flow meter)
- Engineers tape, 25 feet long, marked in 10ths and 100ths of a foot
- Appropriate Health and Safety Equipment.

5.0 DISCHARGE MEASUREMENT PROCEDURES

Surface water discharge conditions vary geographically and seasonally. This SOP describes possible discharge conditions that may be encountered and methods to be used based on the site-specific discharge conditions.

Depending on the magnitude of the discharge and the physical conditions at the measurement site, surface water discharge shall be measured with one of the following: (1) flow meter, (2) portable cutthroat flume, (3) permanent flume, (4) permanent V-notch weir, (5) time and volume (stopwatch and a bucket or tank), or (6) time and distance (stopwatch and a measuring tape).

If none of these six methods can be used to measure discharge at a particular sample location, then: (1) the measurement site may be relocated so that discharge can be measured, (2) the measurement site may be eliminated, or (3) other methods may be selected and added as addenda to this SOP.

5.1 LOCATION OF DISCHARGE MEASUREMENT SITES

The discharge measurement site selection depends on a number of factors, including data acquisition requirements, accessibility, and discharge characteristics. When surface water discharge is measured in coordination with water-quality sampling, take discharge measurements as close as possible to the sample collection point. To avoid disturbing the sediments or otherwise contaminating samples, measure discharge after collecting water-quality samples and immediately downstream of the sample collection point. Surface water discharge characteristics shall be used to determine the exact point where the discharge measurements will be made and the method used for measuring discharge; these

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characteristics include ease of measurement, channel alignment, flow regime, flow depth, and velocity. Consider the following factors when selecting a discharge measurement site:

1. Ease of measurement. The discharge measurement site should be accessible to wading, and flow should be confined to a definable channel. Because surface water discharge measurement will require wading in the stream, be sure that the flow depth and velocity are sufficiently low to permit safe crossing.
2. Flow regime. Surface water flow should be steady and uniform, the stream-bed gradient in the vicinity should be relatively constant, and flow-lines should be as close to parallel as possible.
3. Backwater effects. The discharge measurement site should be free from backwater caused by downstream obstructions or by the confluence of the stream with a major tributary or other body of water.
4. Depth and velocity limitations. Certain types of flow meters must have a sufficient depth and velocity of water (e.g., Marsh-McBirney flow meter) to function properly. The meter used should be evaluated to ensure it will perform properly at the selected discharge measurement site.

5.2 FLOW METERS

5.2.1 Theoretical Considerations

The flow volume rate of water, which is commonly called discharge (Q), is calculated as follows:

$$Q = VA$$

where:

V = the average stream velocity for the entire cross section

A = the total cross-sectional area.

The current meter measures velocity at a point. The velocity-area method of making discharge measurements at a cross section requires measurement of the mean velocity in multiple portions of the cross section at each of the selected vertical locations. These are taken at subsections of the cross section. A complete discussion of velocity observation methods is found in "Measurement of Stage and Discharge," (Rantz et al, 1982).

By dividing the stream width into subsections, total discharge becomes the sum of the discharges measured in each subsection. Table 1 provides guidelines for the number of subsections that should be used for varying stream widths. An individual point velocity (v) is measured at each subsection, and the total discharge is the sum of the products of each point velocity and cross-sectional area of each subsection, as follows:

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Table 1
NUMBER OF SUBSECTIONS BASED ON STREAM WIDTH

Approximate Stream Width (ft)	Approximate Number of Subsections	Approximate Distance between Subsections (ft.)
<2	8 – 10	0.2 - 0.3
2 - 4	10 - 12	0.3 - 0.4
4 – 10	12 - 15	0.4 - 0.7
10 – 20	15 - 20	0.7 - 1.0
>20	20 - 25	1.0 - 2.0

$$Q = \sum va$$

where:

n = the number of subsections in the cross section

v = point velocity

a = the area of each subsection.

A cross section is defined by depths at vertical locations 1 through n (See Figure 1). At each vertical location, the point velocity is measured by a current meter.

5.2.2 Flow Meter Measurement

A Marsh-McBirney magnetic current meter is the recommended flow meter for measuring water velocity. The Marsh-McBirney meter provides a direct velocity reading in cfs and is rugged for field use. If another flow meter is used, refer to its operation manual for proper use.

Either Model 201D or Model 2000 Marsh-McBirney meters are recommended for the flow velocity measurements. The Marsh-McBirney meters measure flow velocity using the Faraday principle, which states that as a conductor moves through and cuts lines of magnetic flux, a voltage is produced. The magnitude of the generated voltage is directly proportional to the velocity at which the conductor moves through the magnetic field.

The selector switch of the Model 201D has five positions; these positions are OFF, CAL, FT/SEC, NI/SEC, and KNOTS. To check for electronics failure or discharged batteries, switch the selector to the CAL position and the time constant switch to the A2 setting. The meter should count down and turn itself off. If this does not happen, change the batteries and repeat the above check. The time constant

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switch is used to help stabilize the velocity readings. Generally, begin with the smallest time constant setting and increase the setting until the readout velocity stabilizes.

The sensor on the Marsh-McBirney meter can be connected to the universal sensor mount on the top-setting wading rod and used to determine flows using the six-tenths depth method. The minimum flow depth at which an average velocity can be measured with the Marsh-McBirney meter set at six-tenths of total depth is approximately 0.18 feet. Velocities can be estimated in flows as shallow as 0.1 feet. The meter is capable of measuring velocities ranging from 0 to 20 fps.

Under open channel laminar flow conditions, the effect of fluid contact with the bed of a stream channel and the air is a vertical distribution of velocities. Consistent with this velocity distribution, actual observation and mathematical theory has demonstrated that a single measurement of velocity taken at 0.6-depth below the surface accurately results in mean velocity in the vertical (Rantz et al, 1982).

In the 0.6-depth method, an observation of velocity made in the vertical at 0.6 of the depth below the surface is used as the mean velocity in the vertical. A depth of 1.25 feet will accommodate the 0.6-depth method without causing the meter to be set closer than 0.5 feet from the streambed; if the meter is set any closer to the streambed, it will under-register the velocity.

5.2.3 Required Discharge Measurement Site Conditions

In order to make a velocity-area discharge measurement, the following conditions are required:

1. The stream must be channelized; that is, observable banks must channel the stream flow.
2. The depth must be greater than 0.2 foot across most of the cross section being measured.
3. The stream must have a measurable velocity of at least 0.1 fps in most of the cross section.

Conditions No. 2 and 3 can often be met in streams of very low discharge by conservatively modifying the stream channel to produce a narrower and slightly deeper cross section in order to meet measurement requirements. These modifications may include removal of aquatic growth or ice, moving large stones which impact velocity upstream or downstream of the cross section, and narrowing or deepening the cross section. When such modifications are made, great care shall be exercised to avoid unnecessary movement of sediments. After clearing the cross section, allow the flow to stabilize before measuring the flow.

Current meter measurements are best made by wading, if conditions permit. Wading measurements have a distinct advantage over measurements made from cableways or bridges in that it is usually possible to select the best of several available cross sections for the measurement.

5.3 FLOW METER DISCHARGE MEASUREMENT PROCEDURES

The following steps are to be followed in discharge measurement:

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1. Evaluate the measurement site. Chose a location where discharge is least turbulent. If the prescribed location is in a stream reach with highly turbulent discharge conditions, try to select a location immediately upstream or downstream from the prescribed location. Flow should be visible from bank to bank. Eddies and slack water must not be present.
2. Remove aquatic vegetation, ice, or other minor discharge impediments. When such modifications are made, exercise great care to avoid unnecessary movement of sediments or the splashing of sediments or water onto sampling personnel. Allow discharge to stabilize before the discharge measurement begins.
3. Position a fiberglass tape about 1 foot above the surface of the water. Secure the tape so that it remains taut and perpendicular to the stream channel.
4. Select a starting point at either the left edge of water (LEW) or right edge of water (REW). LEW and REW are determined when facing downstream.
5. If sampling personnel relocate the measurement site due to conditions stated in Section 5.2.3, the distance in feet, and the stream direction from the prescribed location shall be noted in the field notebook.
6. Measure the stream width in feet. Follow guidelines in Table 1 to select the number of subsections in which to measure velocity.
7. After determining the distance desired between measuring points, commonly referred to as sections, measurement can begin. Record the time and bank at which measurement starts in the field notebook.
8. Note the distance to the beginning edge of water from the initial point. The initial point is an arbitrary point on the tape, preferably zero, which lies on the shoreside of the stream. All station locations are recorded as distances from the initial point (See Figure 1).
9. Proceed to the first station beyond the edge of water. Record the distance from the initial point field notebook. Place the wading rod into the stream so the base plate rests on the stream bed.
10. Stand downstream of the fiberglass tape and face upstream. Do not stand behind or close to the meter. Raise the current meter on the wading rod so that it is well above the surface of the water.
11. Measure stream depth at the measurement point as indicated on the wading rod. Record the stream depth to the nearest 0.02 foot.
12. Lower the flow meter to the required depth and record the observation depth. The observation depth is a fraction (0.6) of total depth.
13. Stand downstream of the meter with the arm fully extended holding the wading rod. Find a position so that the angle measured between the arm and the fiberglass tape is approximately 45 degrees. Stand as far away from the vertically held wading rod as possible.

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14. Begin discharge measurements as per the manufactures specifications.
15. Proceed to the next station. Record the distance from the initial point to the station. Repeat steps 10 through 14 at each station across the stream.
16. After recording the discharge measurement at the last station, record the time at which the ending edge of water is reached in the field notebook.
17. Note velocity and depth at the edge of water as zero.
18. Evaluate and record the following: Flow characteristics, weather conditions, air temperature, water temperature, observer(s), type of flow meter, and remarks on the Surface Water Discharge form (Appendix C of the QAPP).
19. If less than 20 subsections have been used for the measurement, repeat the measurement steps. Begin from the opposite bank from where the previous measurement began.
20. Decontaminate flow meter equipment following all discharge measurements at each site in accordance with SOP No. 10 Decontamination.

5.3.1 Discharge Calculations

Calculate discharge as follows:

1. Use the distances from the initial point on the shoreside (an arbitrary position beyond the edge of the water as shown in Figure 1) to compute the width for each station. The first width is computed by subtracting the first distance (edge of water) from the second distance, and dividing this quantity by two. The second width will be the difference between the third distance and the first distance, divided by two. For each subsequent width, subtract the previous station distance from the following station distance, and divide by two. The final width is calculated as the value of the difference between the final distance and the second-to-last distance, divided by two. Sum the width column and check that the width equals the distance between the REW and LEW.
2. Multiply the width by the depth for each station to determine its area. Sum the areas to determine the total area.
3. Multiply the velocity by the area for each station to obtain its discharge measurement.
4. Sum the discharge measurements for each station to determine total discharge and record the value. A single measurement of velocity taken at 0.6 of the depth below the surface accurately results in mean velocity in the vertical (Rantz et al, 1982).
5. If two sets of discharge measurements beginning at opposite banks were taken, repeat the discharge calculations for the second set of data. Average the total discharges for the two measurements.

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5.4 FLUMES

Flumes are specially shaped open-channel devices that constrict channel area and change the slope to force the discharge through critical depth. Typical flumes consist of three sections:

- A converging section to accelerate the approaching surface water discharge.
- A throat section, whose width is used to designate flume size.
- A diverging section, designed to ensure that the level downstream is lower than the level in the converging section.

The hydraulic theory behind flumes is based on a calibrated constriction placed to change the level of the water in or near the constriction. By knowing the dimensions of the constriction, the discharge through the constriction will be a function of the water level. A simple depth determination near the constriction provides a discharge measurement. Flumes are constructed so that a restriction in the channel causes the water to accelerate, producing a corresponding change (drop) in the water level that can then be related to the discharge.

The discharge rate through a flume is determined by measuring the gage (flow depth) at a single point upstream from the throat. The gage height measurement determines the discharge only if critical discharge is achieved in the throat of the flume. By definition, critical discharge occurs when the ratio of the force due to inertia to the force due to gravity (Froude number) is unity. Supercritical discharge occurs when the Froude number exceeds unity. If the Froude number is less than one, subcritical discharge occurs, commonly due to a condition referred to as submergence. If submergence exists, a second depth reading must be taken in the throat section to determine the discharge rate. Additional information concerning the use of flumes under all discharge conditions, including submergence, is detailed in Rantz et al, 1982.

5.4.1 Parshall Flume Discharge Measurement Procedures

The Parshall flume consists of a permanently installed flume that has a converging section with a level floor, a throat section with a downward-sloping floor, and a diverging section with an upward-sloping floor. The principal feature of the Parshall flume (developed by R. Parshall in 1922) is an approach reach having converging sidewalls and a level floor of which the downstream end is a critical-depth section. Critical discharge is established at the throat due to a sharp downward break in the slope of the flume. The discharge downstream from the level approach section is therefore supercritical. The primary gage height measurement is made in the approach reach at a standard distance upstream from the critical-depth cross section.

The following steps shall be performed when measuring discharge from a permanent flume:

1. Remove any material that may have accumulated in the flume.

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2. Remove any material that may have accumulated downstream of the flume and is causing water to back up in the flume.
3. Note any deterioration of the flume in the field notebook and report these conditions to the Project Manager at the conclusion of daily collection activities.
4. Measure and record the throat width to the nearest 0.01 foot in the field notebook.
5. Record the time and date of discharge measurement in the field notebook.
6. Use the staff gage to measure and record the gage height to the nearest 0.02 foot in the field notebook.
7. Calculate discharge using appropriate tables or equations (See Table 2).

Table 2
FREE FLOW DISCHARGE – PARSHALL FLUME, CFS

Head, H_0 Feet	Size of Flume, 14'											
	3"	6"	9"	1'8"	1'6"	2'0"	3'0"	4'0"	5'0"	6'0"	7'0"	8'0"
0.1	0.028	0.05	0.09	--	--	--	--	--	--	--	--	--
0.2	0.082	0.16	0.26	0.35	0.51	0.66	0.97	1.26	--	--	--	--
0.3	0.154	0.31	0.49	0.64	0.94	1.24	1.82	2.39	2.96	3.52	4.08	4.62
0.4	0.241	0.48	0.76	0.99	1.47	1.93	2.86	3.77	4.68	5.57	6.46	7.34
0.5	0.339	0.69	1.06	1.39	2.06	2.73	4.05	5.36	6.66	7.94	9.23	10.51
0.6	0.450	0.92	1.40	1.84	2.73	3.62	5.39	7.15	8.89	10.63	12.36	14.08
0.7	0.571	1.17	1.78	2.33	3.46	4.60	6.86	9.11	11.36	13.59	15.82	18.04
0.8	0.702	1.45	2.18	2.85	4.26	5.66	8.46	11.25	14.04	16.81	19.59	22.36
0.9	0.843	1.74	2.61	3.41	5.10	6.80	10.17	13.55	16.92	20.29	23.66	27.02
1.0	0.992	2.06	3.07	4.00	6.00	8.00	12.00	16.00	20.00	24.00	28.00	32.00
1.1	--	2.40	3.55	4.62	6.95	9.27	13.98	18.60	23.26	27.94	32.62	37.30
1.2	--	2.75	4.06	5.28	7.94	10.61	15.96	21.33	26.71	32.10	37.50	42.89
1.3	--	--	4.59	5.96	8.99	12.01	18.10	24.21	30.33	36.47	42.62	48.78
1.4	--	--	5.14	6.68	10.10	13.48	20.32	27.21	34.11	41.05	47.99	54.95
1.5	--	--	--	7.41	11.20	15.00	22.64	30.34	38.06	45.82	53.59	61.40
1.6	--	--	--	8.18	12.40	16.58	25.05	33.59	42.17	50.79	59.42	68.10
1.7	--	--	--	8.97	13.60	18.21	27.55	36.96	46.43	55.95	65.48	75.08
1.8	--	--	--	9.79	14.80	19.90	30.13	40.45	50.83	61.29	71.75	82.29

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Head, H_0 Feet	Size of Flume, 14'											
	3"	6"	9"	1'8"	1'6"	2'0"	3'0"	4'0"	5'0"	6'0"	7'0"	8'0"
1.9	--	--	--	10.62	16.10	21.63	32.79	44.05	55.39	66.81	78.24	89.76
2.0	--	--	--	11.49	17.40	23.43	35.53	47.77	60.08	72.50	84.94	97.48
2.1	--	--	--	12.37	18.80	25.27	38.35	51.59	64.92	78.37	91.84	105.40
2.2	--	--	--	13.28	20.20	27.15	41.25	55.52	69.90	84.41	98.94	113.60
2.3	--	--	--	14.21	21.60	29.09	44.22	59.56	75.01	90.61	106.20	122.00
2.4	--	--	--	15.16	23.00	31.09	47.27	63.69	80.25	96.97	113.70	130.70
2.5	--	--	--	16.13	24.60	33.11	50.39	67.93	85.62	103.50	121.40	139.50

Note: Approximate values of flow for heads other than those shown may be found by direct interpolation in the table.

- Record the calculated discharge (should any leakage occur around the flume, the amount of leakage is estimated as a percentage of the total measured discharge and is added to the calculated discharge value) in the field notebook.

5.4.2 Portable Cutthroat Flume Discharge Measurement Procedures

A portable cutthroat flume with interchangeable throat widths, typically ranging from 1 to 8 inches, can be used to measure most discharges. Set-up and measurement with the cutthroat flume are significantly easier and faster than with a flow meter, and the flume is more accurate when installed properly. Place a portable cutthroat flume in a section of the stream channel with a bed slope of less than approximately 1 percent for a distance of 4 to 6 feet upstream of the flume. When the proper throat width is used, a pool of water with a width at least twice the front width of the flume should form upstream of the flume.

The following steps shall be performed when installing and measuring discharge from a portable cutthroat flume:

- Assemble, install, level, plumb, and square the flume.
- Install the flume so that free-flow discharge occurs (flow through the flume discharges freely without backup).
- Divert all stream discharge through the flume inlet, being careful to seal the sides and bottom of the flume so that discharge does not run around or underneath the flume.
- Remove any material that may have accumulated in the flume.
- Record the time and date of discharge measurement in the field notebook.
- After the discharge has equilibrated, use the staff gage to measure and record the gage height to the nearest 0.02 foot in the field notebook.

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7. Take and record in the field notebook two identical staff gage measurements 5 minutes apart to demonstrate that discharge has equilibrated.
8. Calculate discharge using appropriate tables or equations.
9. Record the calculated discharge (should any leakage occur around the flume, the amount of leakage is estimated as a percentage of the total measured discharge and is added to the calculated discharge value) in the field notebook.
10. Remove and decontaminate the portable flume in accordance with SOP No. 10 Decontamination.

5.5 V-NOTCH WEIR DISCHARGE MEASUREMENT PROCEDURES

A V-notch weir is an obstruction or dam built across an open channel over which surface water flows through a V-shaped notch. Generally, the edge of the V-notch is beveled with a sharp upstream corner so that water shoots past the downstream portion of the weir structure without contacting it.

The angle between the legs in the "V" is typically 90 degrees but can be less. As the angle decreases, the accuracy of the measured discharge also decreases. All weirs used will have a 90-degree-angle notch.

In order to obtain accurate discharge measurements, the following conditions must be met when using a 90-degree angle V-notch weir:

- The discharge must be greater than 0.05 and less than 10 cfs.
- The head on the notch (the distance from the bottom of the "V" to the top of water) must be greater than 0.2 feet but less than 2 feet.
- The height of the bottom of the "V" above the stream channel must be at least two times the expected maximum head (see Figure 2).

For a V-notch weir with a 90-degree-angle notch, the discharge is calculated using the equation:

$$Q = 2.5H^{2.5}$$

where:

Q = discharge (cfs)

H = distance from bottom of the "V" to the top of the water (feet).

The following steps shall be performed when measuring discharge from a V-notch weir:

1. Remove any material that may have accumulated in the weir.
2. Remove any material that may have accumulated downstream of the weir and is causing water to backup in the weir.

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3. Note any deterioration of the weir in the field notebook and report these conditions to the Project Manager at the conclusion of daily collection activities.
4. Record the time and date of discharge measurement in the field notebook.
5. Measure and record the distance from the bottom of the "V" to the top of the water to the nearest 0.02 foot in the field notebook.
6. Calculate the discharge using the equation above.
7. Record the calculated discharge (should any leakage occur around the weir, the amount of leakage is estimated as a percentage of the total measured discharge and is added to the calculated discharge value) in the field notebook.

5.6 TIME AND VOLUME DISCHARGE MEASUREMENT PROCEDURES

The time and volume method consists of capturing discharge in a container and measuring the time required to fill the container. When using this method, divert the discharge through a culvert or pipe and measure the discharge at the point of outflow. Alternatively, a small earthen dike can be built to divert spring discharge through a pipe into a container with a known volume. Record the time required to fill the container with a stopwatch.

If practical, repeat the measurement at least three times and average the resulting values. If the variance between the time measurements exceeds 10 percent, repeat the measurement procedure. If any leakage occurs through or around the dike, estimate the amount of leakage as a percentage of the total measured discharge and add the estimated leakage to the measured discharge in order to calculate the total discharge. Decontaminate discharge measurement equipment in accordance with SOP No. 10 Decontamination.

5.7 TIME AND DISTANCE DISCHARGE MEASUREMENT PROCEDURES

In extreme cases where other measurement procedures fail or are not available, stream discharge may be estimated by measuring the time a floating object takes to travel a known distance through a stream cross section of known (or estimated if not known) area. In this method, measure or estimate the area of an average cross section with the procedures described in Section 5.2.1. Measure the time required for a floating object to travel a measured distance (e.g., 10 feet) of a uniform stream section. If possible, select an object that floats immediately below the water surface because such an object will travel at approximately 90 percent of the actual water velocity. Given the time, distance, cross-sectional area, and the 90 percent correction factor, calculate the estimated discharge.

6.0 DOCUMENTATION

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Surface Water Discharge In Streams And Seeps

All information pertaining to stream discharge measurements shall be recorded in a bound field logbook with consecutively numbered pages. Corrections shall be made by line-out deletions that are initialed and dated. If surface water samples are to be collected at the time of discharge measurement, the information can be recorded in a surface water sampling data sheet (Appendix C of the QAPP). The information recorded shall include the following, as appropriate:

- Discharge measurement location
- Date and time
- Method of discharge measurement
- Flow measurement (or data, such as gauge measurement, such that discharge can be calculated)
- Unusual conditions at measurement location or conditions that prevented
- Measurement
- Name of person(s) performing procedures.

The discharge rate result will also be recorded on the Field Measurement Data log (Appendix C) to facilitate entry of data into the project database.

7.0 REFERENCES

Driscoll, Fletcher G., Ph.D. 1986. Groundwater and Wells. Second Edition. Johnson Filtration Systems, Inc., St. Paul, Minnesota.

Rantz, S.E. et al. 1982. Measurement and Computation of Stream Flow, Measurement of Stage and Discharge. United States Geological Survey Water-Supply Paper 2175. U.S. Government Printing Office. Washington, D.C.

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Borehole Geophysical Logging

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Borehole Geophysical Logging

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Borehole Geophysical Logging

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and provides technical guidance and methods that will be used for borehole geophysical logging performed during field activities at the Midnite Mine Site. This SOP is not intended to provide a comprehensive summary of downhole geophysical techniques, but to provide guidance for the techniques planned for the proposed drilling program at the Midnite Mine Site. The proposed downhole, geophysical logging techniques include gamma, caliper, fluid conductivity, and temperature logging.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

Related SOPs include:

- SOP No. 1 Drilling and Sampling of Subsurface Materials
- SOP No. 2 Borehole Logging
- SOP No. 10 Decontamination

4.0 MATERIALS AND EQUIPMENT

The following materials and equipment listed will be needed for downhole geophysical logging:

- Downhole geophysical tools and probes (e.g., portable MT SOPRIS logging unit)
- Waterproof pens
- Stop watch
- Reference tables and manuals

Other materials and equipment may be needed based on field conditions.

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Borehole Geophysical Logging

5.0 PROCEDURES

Geophysical logging techniques employed at the Midnite Mine site are intended to assist in the characterization of the geology and hydrogeology, and selection of well screen intervals. Logging will be performed in open boreholes before monitoring well screen intervals are selected. Gamma and caliper logging will be performed to identify lithologic types (e.g., mineralized zones) and fracture zones. Fluid conductivity and temperature logging will be used to help identify zones of water infiltration into the borehole.

A qualified individual will conduct borehole geophysical logging. For each geophysical tool, calibration data and scale parameters will be verified before logging begins and documented for each borehole. Geophysical data will be stored in hard-copy and electronic formats. After logging, a reproducible copy of the field strip-chart log with a heading specifying project, borehole number, location and depth, geophysical equipment types, and equipment settings will be maintained in the project file.

General requirements for borehole geophysical surveys are: (1) all downhole equipment shall be decontaminated before and after being lowered into a borehole in accordance with SOP No. 10 Decontamination; (2) geophysical logging will be performed in accordance with the manufacturer's specifications; (3) borehole measurements shall be recorded both going into the hole and coming out of the hole; (4) paper copies of curves generated from each logging run shall show all the curves at an appropriate scale (e.g., 1 inch equals 20 feet), each paper log shall indicate the location of the well, date of log acquisition, type of survey instrument, and a list of other instruments used in that borehole, and interpretations shall be annotated on the margins of paper log records; (5) all logs shall be referenced to ground level; (6) radioactive sources or devices shall not be used unless they are explicitly called for in the Sampling and Analysis Plan; and, (7) adverse borehole conditions shall be reported in the field log.

Natural Gamma Ray Logs

Natural gamma ray logging is used to evaluate lithologic characteristics of geologic formations by recording gamma radiation emissions. The gamma ray logging tool contains one or more scintillation detectors that measure the natural radioactivity in geologic layers adjacent to the borehole. Gamma logging may be used in conjunction with caliper logs in fluid-filled boreholes. This technique allows logging through the casing or the well pipe after well construction; however, the radiation measurements are attenuated by well casing.

Caliper Logs

Caliper logs measure the variations in the borehole diameter. A caliper, a spring-loaded mechanical device with one to four adjustable arms that press against the borehole wall, measures the diameter in

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Borehole Geophysical Logging

cased and uncased boreholes. Variations in the borehole diameter, factors such as fracture zones, borehole erosion (washout), the presence of swelling clays or resistant strata, and the volume of filter pack or grout needed for well completion, are determined. Caliper logs are collected by lowering the device to the bottom of the borehole and recording the measurements as the caliper is raised.

Fluid Conductivity

Fluid conductivity data may be used to assess groundwater conductivity, inflow zones and contamination zones. A fluid conductance probe is sensitive to dissolved solid concentrations which may be correlated to mineralized and/or fracture zones. Logging of fluid conductivity is performed in an open, uncased borehole. The logged section of the borehole must be fluid-filled for this tool to work. Careful review of these logs in the field will assist in selecting well screen intervals.

Temperature

Temperature logs provide a continuous record of fluid temperature with depth. Preferential inflow zones may be indicated by an increase or decrease in groundwater temperature based on temperature logs. Inflow zones will be evaluated in conjunction with other geophysical logs to assist in the selection of well screen intervals. Logging of temperature is performed in an open, uncased, fluid-filled borehole.

6.0 DOCUMENTATION

Project and subcontractor staff are responsible for documenting logging activities. Field notes will be kept during logging activities. The following information will be recorded in a bound field log book:

- Names of personnel
- Weather conditions
- Date, time and location of logging
- Description of chosen geophysical technique(s)
- Description of survey set-up and data collection
- Times that procedures and measurements are completed
- Summary of data reduction and preliminary interpretations
- Documentation of all problems encountered
- Decontamination times
- Calibration information
- Other applicable information

SOP NUMBER 14

GPS Surveying

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GPS Surveying

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SOP NUMBER 14

GPS Surveying

1.0 PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to define the procedure for conducting Global Positioning System (GPS) surveying at the Midnite Mine Site. GPS will be used to survey surface water and sediment sampling locations, surface water discharge measurement locations, and locations and top of casing elevations of groundwater monitoring wells.

This SOP only provides general procedures for GPS surveying and is not intended to provide detailed technical information about GPS surveying. This SOP is intended to be used in conjunction with the surveying instrument manufacturer's recommendations and procedures, as well as accepted industry practices.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The surveying will be performed by a surveyor licensed in the State of Washington. The surveyor will be responsible for meeting the specifications described in this SOP and documentation of the survey data.

All personnel performing these procedures are required to have the appropriate health and safety training.

3.0 RELATED STANDARD OPERATING PROCEDURES

This SOP is intended to be used with the following SOPs:

- SOP No. 3 Monitoring Well Installation
- SOP No. 8 Surface Water Sampling
- SOP No. 9 Sediment Sampling
- SOP No. 12 Surface Water Discharge in Streams and Seeps

4.0 EQUIPMENT NECESSARY FOR GPS SURVEYING

The following is a list of equipment that may be needed for conducting GPS surveying for this project:

- Monitoring and personal protective equipment (PPE) as outlined in the Health and Safety Plan (HSP)
- Real-time kinematic (RTK) GPS system (including GPS receiver, antenna, data logger)
- GPS base station

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- Measuring tape (marked in increments of tenths of a foot)
- Survey logbook

5.0 SURVEYING PROCEDURES

This section provides a general summary of GPS surveying procedures and specific procedures for surveying monitoring well and surface water/sediment sampling locations. However, these procedures should be supplemented by the specific survey instrument manufacturer's recommendations and generally accepted surveying practices.

- Coordinates and elevations will be determined based on NAD27 datum and Geoid 96 derived elevations.
- Surveying equipment will be field-verified each day before beginning surveying by establishing the coordinates of a known location (e.g., benchmark) using the GPS unit. The benchmark identification (or description) and measured coordinates will be recorded in the survey logbook.
- A base station will be established within an appropriate distance from the furthest survey point, as determined by the instrument manufacturer's specifications.
- At each survey location, the location identifier and coordinates will be measured and stored in the data logger. As a backup, the same information will be recorded in the survey logbook.
- Data stored in the data logger will be downloaded at the end of each day of surveying and checked to determine if the data is reliable and to verify that coordinates have been collected for each survey location.
- Known benchmarks will be used to establish control points
- If the coordinates at a survey location cannot be determined due to the presence of tree cover or other obstacles which prohibit adequate signal reception, coordinates will be obtained at a minimum of two alternate locations (offsets) close to the original survey location. The distance and bearing from each of the alternate locations to the original survey location will then be determined using a measuring tape and compass.

The following procedure will be followed specifically for surveying monitoring well locations and top of casing elevations:

- Enter the monitor well identification in the GPS data logger and also in the survey logbook for backup purposes.
- Measure the location in state plane coordinates (northing and easting) and elevation of the concrete pad adjacent to the monitoring well protective casing and store the coordinates and elevation in the data logger and record data in the survey logbook.

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- Remove the monitoring well cap and measure the elevation of the top of the inner well casing (not the protective casing) on the north side of the well. Remove all visible debris from the tip of the survey rod before placing the rod on the top of the open well. Measure the top of casing elevation and store the elevation data in the data logger and in the survey logbook.

The following procedure will be followed specifically for surveying surface water and sediment sampling locations:

- Enter the survey location identification in the GPS data logger and also in the survey logbook.
- Place the survey rod at the stream bank adjacent to the sample location and measure the location (northing and easting) in state plane coordinates and the elevation. Store the information in the data logger and record it in the survey logbook.

6.0 DOCUMENTATION

The survey location identifier (i.e., sample location designation or monitoring well designation) and corresponding coordinates and elevation will be recorded in the data logger. As a backup, this information will also be recorded in the survey logbook. Surveying activities and field observations will also be recorded in the survey logbook. Information that will be documented in the logbook include:

- Project name and number
- Surveying personnel
- Weather conditions
- Daily field verification information (i.e., benchmark identification and coordinates)
- Survey location identification
- Survey location coordinates (northing and easting) and elevation
- Descriptions and coordinates of alternate survey locations (offsets)
- Measured distances from alternate survey locations to original survey locations
- A description of any conditions that may affect data integrity.

Appendix C

Field Forms

AppendixC

FieldForms

Appendix D
Laboratory Technical Scopes Of Work

AppendixD

Laboratory Technical Scopes of Work

To be added at a later date

Appendix E

Laboratory Quality Assurance Plan(s) And Standard Operating Procedures

Appendix E Laboratory Quality Assurance Plan(s) and Standard Operating Procedures
